Final Status Survey Report
Volume V– Pond Parcel Excavation Backfill Units

Survey Units Kaiser – FSSB – 010
Through Kaiser – FSSB - 015

Prepared For:

Kaiser Aluminum & Chemical Corporation
Thorium Remediation Project
Tulsa, Oklahoma Facility

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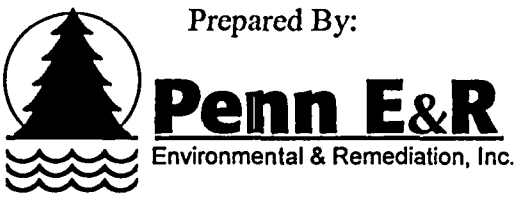

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Penn Environmental & Remediation, Inc. (Penn E&R) has been retained by the Kaiser Aluminum & Chemical Corporation (Kaiser) to provide radiological final status survey technical support for the remediation of its Kaiser Aluminum Specialty Products facility (Tulsa, Oklahoma facility) located at 7311 East 41st Street in Tulsa, Oklahoma. The remediation of radiologically impacted portions of the Tulsa, Oklahoma facility has been authorized by the Nuclear Regulatory Commission (NRC) via approval of the site-specific Decommissioning Plan (DP) (June 2001, Rev. May 2003, September 2003, May 2005, and September 2005) and Decommissioning Plan Addendum (DPA) (May 2002, Rev. May 2003) for the facility. The DP and DPA were designed to address the remediation of thorium dross and contaminated soil known to be present at the Tulsa, Oklahoma facility (Thorium Remediation Project).

The DP addresses the remediation of the impacted portions of the 14-acre "Pond Parcel" at the Tulsa, Oklahoma facility and the DPA addresses the approximate 3.5-acre "Former Operational Area" (FOA). The remediation alternative chosen for the Pond Parcel requires excavating material with a net Th-232 activity concentration greater than the Derived Concentration Guideline Level ($DCGL_w$) of 3.0 pCi/g, based on a dose limit of 25 mrem/yr. Material with net Th-232 activity concentrations greater than the Derived Cutoff Concentration Level (DCCL) of 31.1 net pCi/g Th-232 is being segregated and disposed off site as exempt material at the U.S. Ecology Grand View, Idaho facility. Material with activity concentrations less than 31.1 net pCi/g Th-232 (Below Criteria Material or BCM) is being used as backfill in the Pond Parcel excavation. A layer of clean imported borrow material (minimum thickness of 10 feet) obtained from an off site source is being placed over the BCM and graded in a manner to direct drainage away from the site, after which the site will be revegetated At the time of preparation of Volume IV of the Final Status Survey Report (June 2006), the remediation of the impacted portions of the Pond Parcel had been completed.

Remediation activities for the FOA were similar to those implemented for the Pond Parcel with the exception of the excavations being backfilled with clean imported borrow material. At the time of preparation of Volume II of the **Final Status Survey Report (March 2006)**, the remediation of the impacted portions of the FOA had been completed.

Final status surveys for the Thorium Remediation Project consist of three distinct elements: (1) surveys of the "open land areas" of the site including the excavation bottom surface soils for the Pond Parcel and FOA; (2) surveys of BCM placed in the Pond Parcel

excavations; and (3) surveys of structural surfaces. Final status surveys are completed prior to the backfilling of any Pond Parcel or FOA remediation excavation and during/following the placement of BCM in the Pond Parcel. The survey unit acceptance criteria developed in the DP are applicable to the entire site. Thus, if each survey unit meets the acceptance criteria, the dose for the entire site will be less than the release criteria of 25 mrem/yr.

Pond Parcel Excavation Bottom and FOA Excavation Final Status Surveys

Final status surveys associated with the Pond Parcel and FOA excavation bottoms are conducted through a progression of Class 1 survey units. Survey units typically consist of excavation bottom surface soil and associated side walls, elevated soil areas (if left in-place), and embedded structures (if encountered and left in-place). The final status survey of excavation bottom survey units typically consists of a gross gamma scan of the exposed surface soil of the unit and systematic soil sampling. Additional scanning and soil sampling are included for each elevated measurement comparison (EMC) performed for elevated areas left in-place. Embedded structures (typically small pipes and concrete) are surveyed for total alpha contamination (when possible) and removable alpha contamination.

Compliance with survey unit acceptance criteria is demonstrated by comparison of the average residual contamination for each survey element (excavation bottom soil, elevated areas, and embedded structures) to the appropriate acceptance criteria value and a sum of fractions for each survey unit is also calculated. The sum of fractions is a very conservative assessment of the survey unit. Summing the fractions ensures the survey unit and the entire site will be a small fraction of 25 mrem/yr (the release criterion) when the actual as-left dose assessment is complete. Systematic final status survey data are also evaluated using the Wilcoxan Rank Sum Test procedure.

Final status surveying and reporting have been completed for all 30 Pond Parcel excavation bottom survey units. **Volume I** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSS-001 through Kaiser-FSS-024. **Volume IV** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSS-025 through Kaiser-FSS-030. One of the 30 excavation bottom survey units (Kaiser-FSS-001) consisted of an embedded structure encountered (a buried concrete spillway) during the removal of radiologically impacted soil. A summary of the final status survey results by survey unit is provided below in **Table 1.**

Table 1 – Pond Parcel Excavation Final Status Survey Summary by Survey Unit

Survey Unit	Surface Area (m^2)	No. of Systematic Samples Collected	Systematic Sample Exceedance of DCGL Value	WRS Test Criterion Met	Elevated Area(s) Present	Embedded Structure(s) Present	Total Sum of Fractions	Survey Unit Meets DP Acceptance Criteria
Kaiser-FSS-001*	84.5	36	YES	YES	YES	N/A	0.47	YES
Kaiser-FSS-002	126.5	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-003	80	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-004	107	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-005	35	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-006	2,670	12	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-007	1,182	16	NO	YES	NO	YES	0.04	YES
Kaiser-FSS-008	424	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-009	1,000	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-010	986	10	NO	YES	NO	YES	0.00	YES
Kaiser-FSS-011	2,400	12	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-012	2,460	12	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-013	1,320	10	NO	YES	YES	YES	0.38	YES
Kaiser-FSS-014	1,892	10	NO	YES	YES	YES	0.67	YES
Kaiser-FSS-015	1,997	10	NO	YES	NO	YES	0.18	YES
Kaiser-FSS-016	2,484	14	NO	YES	YES	NO	0.79	YES
Kaiser-FSS-017	2,230	17	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-018	1,582	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-019	1,582	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-020	1,570	9	NO	YES	YES	NO	0.19	YES
Kaiser-FSS-021	1,985	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-022	1,840	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-023	1,750	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-024	1,454	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-025	1,930	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-026	1,300	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-027	1,680	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-028	1,835	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-029	1,481	10	NO	YES	NO	YES	0.25	YES
Kaiser-FSS-030	1,876	9	NO	YES	NO	YES	0.26	YES

* Survey Unit Kaiser- FSS-001 is the buried concrete spillway structure. The other pond parcel survey units are defined as open land areas.

Final status surveying and reporting have been completed for all 9 FOA excavation survey units. **Volume II** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSSFOA-001 through Kaiser-FSSFOA-009.

Three of the nine FOA excavation survey units consisted only of embedded structures (retaining walls) that were encountered during the removal of radiologically impacted soil located adjacent to the structures. A summary of the final status survey results by survey unit is provided below in **Table 2.**

Table 2 – FOA Excavation Final Status Survey Summary by Survey Unit

Survey Unit	Surface Area (m^2)	No. of Systematic Samples Collected	Systematic Sample Exceedance of DCGL Value	WRS Test Criterion Met	Elevated Area(s) Present	Embedded Structure(s) Present	Total Sum of Fractions	Survey Unit Meets DP Acceptance Criteria
Kaiser-FSSFOA-001	228	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSSFOA-002	49	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSSFOA-003*	35	21	NO	YES	NO	N/A	0.16	YES
Kaiser-FSSFOA-004	84	10	NO	YES	NO	YES	0.15	YES
Kaiser-FSSFOA-005	1,320	9	NO	YES	NO	YES	0.03	YES
Kaiser-FSSFOA-006	2,550	13	NO	YES	YES	YES	0.59	YES
Kaiser-FSSFOA-007*	81.5	18	NO	YES	NO	N/A	0.07	YES
Kaiser-FSSFOA-008*	9.3	14	NO	YES	NO	N/A	0.09	YES
Kaiser-FSSFOA-009	19.5	10	NO	YES	NO	NO	0.00	YES

* Survey unit consists of a structure (cinderblock or concrete retaining wall) encountered during the removal of radiologically impacted soil.

Pond Parcel Excavation Backfill Units (BCM) Final Status Surveys

As with the Pond Parcel excavation bottoms, final status surveys associated with the Pond Parcel excavation backfill units (BCM) are conducted through a progression of Class 1 survey units. Typically a unit of BCM is placed in a portion(s) of a pond parcel excavation bottom(s) associated with a defined excavation bottom final status survey unit(s). Backfill units are completed through the placement of typically four to eight continuous layers (2-foot compacted lift depth) of BCM in a defined area. The final status survey of excavation backfill units consists of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit. Compliance with survey unit acceptance criteria is demonstrated by comparison of the average residual contamination for the survey unit to the appropriate acceptance criteria value. Systematic soil core sampling data are also evaluated using the Wilcoxan Rank Sum Test procedure.

Final status surveying and reporting have been completed for all 15 Pond Parcel excavation backfill survey units (Survey Units Kaiser-FSSB-001 through Kaiser-FSSB-015). **Volume III** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSSB-001 through Kaiser-FSSB-009. **Volume V** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-

FSSB-010 through Kaiser-FSSB-015. A summary of the final status survey results by survey unit is provided below in **Table 3.**

Table 3 – Pond Parcel Excavation Backfill Final Status Survey Summary by Survey Unit

Survey Unit	Base Surface Area (m^2)	No. of Systematic Soil Cores	No. of Systematic Soil Core Composite Samples	Systematic Soil Core Sample Exceedance of DCCL Value	WRS Test Criterion Met	Elevated Area(s) Present	Survey Unit Meets DP Acceptance Criteria
Kaiser-FSSB-001	2,220	11	28	NO	YES	NO	YES
Kaiser-FSSB-002	2,405	12	17	NO	YES	NO	YES
Kaiser-FSSB-003	1,709	11	37	NO	YES	NO	YES
Kaiser-FSSB-004	1,647	9	33	NO	YES	NO	YES
Kaiser-FSSB-005	1,716	9	34	NO	YES	NO	YES
Kaiser-FSSB-006	2,177	12	44	NO	YES	NO	YES
Kaiser-FSSB-007	1,381	9	44	NO	YES	NO	YES
Kaiser-FSSB-008	1,431	9	45	NO	YES	NO	YES
Kaiser-FSSB-009	1,840	9	20	NO	YES	NO	YES
Kaiser-FSSB-010	1,770	9	28	NO	YES	NO	YES
Kaiser-FSSB-011	1,754	11	22	NO	YES	NO	YES
Kaiser-FSSB-012	1,840	9	38	NO	YES	NO	YES
Kaiser-FSSB-013	1,620	9	28	NO	YES	NO	YES
Kaiser-FSSB-014	1,660	10	41	NO	YES	NO	YES
Kaiser-FSSB-015	1,820	9	40	NO	YES	NO	YES

Bounding As-Left Condition Final Dose Assessment

A bounding as-left condition dose assessment based on the maximum activity concentration of the BCM and minimum clean soil cover requirement has been completed for the Thorium Remediation Project. The resulting maximum dose is 1.33 mrem/yr. At the conclusion of the Thorium Remediation Project, the actual activity concentrations and the actual dimensions of the cover could be used to reassess the final dose. Since the activity concentrations will be less than bounding values used and the dimensions of the cover will be at least what were used, the resulting dose would be less than 1.33 mrem/yr.

Final Status Survey Report
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1.0 ROAD MAP – VOLUMES I THROUGH V

Penn Environmental & Remediation, Inc. (Penn E&R) has been retained by the Kaiser Aluminum & Chemical Corporation (Kaiser) to provide radiological final status survey technical support for the remediation of its Kaiser Aluminum Specialty Products facility (Tulsa, Oklahoma facility) located at 7311 East 41st Street in Tulsa, Oklahoma **(Figure 1)**. The remediation of radiologically impacted portions of the Tulsa, Oklahoma facility has been authorized by the Nuclear Regulatory Commission (NRC) via approval of the site-specific Decommissioning Plan (DP) (June 2001, Rev. May 2003, September 2003, May 2005, and September 2005) and Decommissioning Plan Addendum (DPA) (May 2002, Rev. May 2003) for the facility. The DP and DPA were designed to address the remediation of thorium dross and contaminated soil known to be present at the Tulsa, Oklahoma facility (Thorium Remediation Project). The DP and DPA specify the procedures to safely decommission the Tulsa, Oklahoma facility and meet the NRC requirements for unrestricted use: residual radioactivity distinguishable from background will not result in a total effective dose equivalent (TEDE) to an average member of a critical group (resident farmer) that exceeds 25 millirem per year (mrem/yr). Additionally, implementation of the DP and the DPA will reduce residual radioactivity to levels that are as low as reasonably achievable (ALARA).

The final status survey technical approach authorized by the NRC (Chapter 14.0 of the DP and DPA) includes the protocols and guidance provided in NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (USEPA, December 1997) to demonstrate compliance with the DP and DPA release criteria. A copy of the most recent version (September 2005) of Chapter 14.0 is presented as an appendix to the Final Status Survey Report.

This Road Map was written to provide the reader with relevant background information related to the DP and DPA, a historical operations perspective for the site, as well as an overview of current site remediation and associated final status survey activities.

1.1 Decommissioning Plan and Decommissioning Plan Addendum

The DP addresses the remediation of the impacted portions of the 14-acre "Pond Parcel" at the Tulsa, Oklahoma facility and the DPA addresses the approximate 3.5-acre "Former Operational Area". The Pond Parcel has been divided into three parts: the non-impacted former Freshwater Pond area to the west (approximately 4 acres); the impacted

Retention Pond/Reserve Pond area to the east (approximately 9 acres); and the impacted area adjacent to the Flux Building and paved area (approximately 1 acre) **(Figure 2)**.

The Former Operational Area (FOA) is principally a triangular parcel of land north of 41st Street and south of the Union Pacific Railroad right-of-way, on which plant processes and operations occurred. None of the original buildings which housed magnesium-thorium alloy processing, existed on site at the onset of the Thorium Remediation Project. The Flux Building, located to the northeast of the triangular parcel, is part of the FOA **(Figure 2)**.

1.2 Historical Operations Perspective

The Standard Magnesium Corporation (SMC) built the Tulsa, Oklahoma facility in Tulsa, Oklahoma in the early to mid-1950s to manufacture magnesium products. SMC received a source materials license (C-4012) from the Atomic Energy Commission in March 1958 to receive possession and title to magnesium-thorium alloy (a thorium metal) with up to 4 percent thorium content for processing. Historical operations at the facility included the smelting of scrap magnesium alloy for the production of anodes. Scrap magnesium-thorium alloy was smelted, along with other magnesium materials, to recover the magnesium. Thorium alloy material comprised a small fraction of the total magnesium refined on site. Licensed operations involving the recovery of magnesium-thorium alloy began in 1958 and continued through 1968. Kaiser purchased the facility in 1964. Magnesium refining operations continued at the facility until approximately 1985. Aluminum then replaced magnesium in smelting and anode manufacture, and the plant continued operating until the 1997-1998 time frame.

License C-4012 was superseded by License STB-472 in November 1961. License STB-472 was amended in June 1968 to add uranium to the list of authorized materials, but there is no record that uranium-bearing materials were ever received on site. The license was terminated in 1971 by the AEC at Kaiser's request. At that time, Kaiser stated that it had not processed magnesium-thorium alloy in the past year.

The scrap magnesium alloy refining process consisted of placing the material into large melting pots, heating the material until molten, and then siphoning off the pure magnesium. Impurities from the mixture, including thorium, separated from the magnesium. This residue material was removed, allowed to cool, and crushed. The crushed material was returned to the heating pots for a second recovery process. Once refined, the metallic dross residue material was crushed and disposed on site.

The quantity of licensed material SMC and later Kaiser were authorized to possess at one time was periodically amended, but generally was limited to 30,000 pounds of magnesium-thorium alloy containing no more than 4 percent thorium. Records documenting the quantity of licensed material present at the site are not available.

1.3 Site Remediation

The site has been divided into two remediation areas: the Pond Parcel area where the dross residues were stored and the FOA where the site structures were located. These two areas and the planned/completed remedial activities are described in the following sections.

1.3.1 Pond Parcel Description and Remediation

Extensive site characterization activities were conducted within the 14-acre land area of the facility known as the Pond Parcel. These characterization activities indicated the presence of residual radioactive material within a 10-acre portion of the Pond Parcel. The radioactive material identified within this portion of land was a thorium-bearing dross containing the isotopes thorium-232 (Th-232), thorium-230 (Th-230), and thorium-228 (Th-228). No elevated uranium was detected. Th-228 and Th-232 were determined to be in secular equilibrium. In addition, a ratio of Th-230-to-((Th-232+Th-228)/2) of 3.5 was calculated based on characterization data.

As previously mentioned, the impacted portion of the parcel contains the Retention Pond and former Reserve Pond area. The non-impacted portion of the Pond Parcel contains the former Freshwater Pond area. The DP was written to address the remediation of the Pond Parcel land area. The impacted Pond Parcel land area is bounded by the south fence line, the former Freshwater Pond embankment on the west, Fulton Creek ditch on the north, and the east fence line. A central feature of this area is the Retention Pond and associated embankments.

Thorium-bearing dross was also present on land adjacent to current Kaiser Property along the east and south fence lines and represented the margins of the impacted material. Per an NRC-approved remediation plan, Kaiser remediated this "adjacent land" by excavation and storing impacted soil within the Pond Parcel. Kaiser conducted the adjacent land remediation project (ALRP) during the period of October 2000 through May 2001. Impacted soil generated during the ALRP was considered part of the on-site decommissioning. In a letter dated March 7, 2002, the NRC provided Kaiser with a determination that the remediated adjacent properties met the criteria for unrestricted release.

The remediation alternative chosen for the Pond Parcel requires excavating material with a net Th-232 activity concentration greater than the Derived Concentration Guideline Level ($DCGL_w$) of 3.0 pCi/g, based on a dose limit of 25 mrem/yr. Material with net Th-232 activity concentrations greater than the Derived Cutoff Concentration Level (DCCL) of 31.1 net pCi/g Th-232 is being segregated and disposed off site as exempt material at the U.S. Ecology Grand View Idaho facility. Material with activity concentrations less than 31.1 net pCi/g Th-232 (Below Criteria Material or BCM) is being used as backfill in the Pond Parcel excavation. A layer of clean imported borrow material (minimum thickness of 10 feet) obtained from an off-site source is being placed

over the BCM and graded in a manner to direct drainage away from the site, after which the site will be revegetated.

At the time of preparation of Volume IV of the Final Status Survey Report (June 2006), the remediation of the impacted portions of the Pond Parcel had been completed. The remediated portion of the Pond Parcel has been excavated to depths up to 15 to 20 feet and to an average depth estimated at 14 feet across most of the Retention and Reserve ponds. At the end of the Thorium Remediation Project, approximately 4,000,000 cubic feet (ft^3) of clean off-site soil will have been used to backfill the Pond Parcel excavations.

1.3.2 Former Operational Area (FOA) Description and Remediation

The DP identified the potential for radioactive material beneath several paved areas and building floor surfaces of the FOA. This determination was based upon an interpretation of historical data and/or observations made during the ALRP. As a result, a limited Additional Site Characterization Activities (ASCA) effort was conducted in the FOA during mid-2001. The objective of the ASCA was to determine if thorium-bearing dross/radioactive material was present beneath these areas of concern. Soil data obtained during the ASCA indicated the presence of residual radioactive material beneath several concrete-paved surfaces at relatively shallow depths. The presence of this material beneath the surfaces was most likely the result of historical grading activities.

A Historical Site Assessment (HSA) was then performed during late 2001 for the FOA. The HSA was conducted as the first step toward decommissioning the FOA at the Tulsa, Oklahoma facility. The objective of the HSA was to compile as much historical information as possible for the facility and, using the MARSSIM guidelines, categorize the land areas and structures of the FOA of the facility as either impacted or non-impacted. None of the original buildings which housed magnesium-thorium alloy processing existed on site at the time of the HSA. With the exception of the Flux Building, there were no buildings in the FOA of the facility classified as impacted in the HSA. The Flux Building was initially classified as an impacted structure due to past and current uses of the building to house and process soil core and surface samples. Land areas initially classified as impacted included the land areas beneath the Maintenance Building, the Crusher Building, the Crusher Addition Building, the North Extrusion Building, the Warehouse Building, and the former Smelter Building, as well as concrete paved areas completed post-1958 (**Figure 2**).

The results of the HSA (Appendix A of the DPA) were used to design radiological survey efforts for the structures and land areas of the FOA. The recommended radiological extended scoping (non-impacted structures) and characterization (impacted land areas) survey efforts were described in a work plan prepared by Earth Sciences Consultants, Inc. (December 2001). The primary objective of the extended scoping survey of the six existing site structures were to verify their initial classification as non-impacted in the HSA. The primary objectives of the characterization survey of the impacted land areas were to determine the nature and extent of residual radioactive materials within the FOA and collect sufficient data to support evaluation of remedial alternatives and technologies

for the impacted land areas of the FOA. The radiological survey efforts were completed during the months of January and February 2002. Results of the radiological surveys are presented in Chapter 4.0 of the DPA.

Based on the results of the survey effort, select land areas of the FOA were identified for remediation. These areas include the following:

- A portion of the land area beneath the former Warehouse Building (Survey Unit Kaiser-FSSFOA-005).
- A portion of the land area beneath the former Crusher Building (Survey Unit Kaiser-FSSFOA-006).
- The land area beneath a "built-up" dock area located immediately west of the former Crusher Building (Survey Unit Kaiser-FSSFOA-005).
- The land area beneath a built-up dock area located immediately west of the former Maintenance Building (Survey Unit Kaiser-FSSFOA-004).
- A portion of the land area beneath a paved concrete surface situated northwest of the former Maintenance Building, northeast of the former North Extrusion Building, and south of the Union Pacific Railroad right-of-way (Survey Unit Kaiser-FSSFOA-001).
- A portion of the land area along a concrete retaining wall situated at the southeastern corner of the former Maintenance Building (Survey Unit Kaiser-FSSFOA-002).
- A portion of the land area beneath a paved concrete surface situated to the north of the former Warehouse Building (Survey Unit Kaiser-FSSFOA-005).
- A portion of the land area beneath a paved concrete surface situated north of 41st Street and the former Crusher Building, south of the UPRR right-of-way, and west of the areas remediated during the ALRP (Survey Unit Kaiser-FSSFOA-006).

Kaiser completed select pre-decommissioning activities prior to undertaking the Thorium Remediation Project. The most significant pre-decommissioning activity was the demolition of several of the non-impacted FOA structures to facilitate the excavation of impacted material located beneath floor slabs. Non-impacted structures that were demolished included the Warehouse Building, the Crusher Building, and Crusher Addition Building. The Flux Building was demolished during the Thorium Remediation Project following the completion of a final status survey of the structure and NRC approval (August 1, 2005 NRC letter from John T. Buckley to Bill Vinzant). The demolished materials were disposed as construction debris off-site at a local permitted facility. The concrete floor slabs and paved surface concrete were removed in sections. The underside of each section of concrete was mechanically cleaned to remove loose soil and clearance surveyed based on the guidance of NRC FC 83-23. In addition, relative to the disposal of the cleared concrete slabs in a local permitted facility, the State of Oklahoma specified that contamination levels shall not be different than background.

At the time of preparation of Volume II Final Status Survey Report (March 2006), the remediation of the impacted portions of the FOA had been completed. Remediation activities for the FOA consisted of the excavation of material with a net Th-232 activity concentration greater than the $DCGL_w$ of 3.0 pCi/g and the backfill of the excavations with clean imported borrow material. The excavated material was transported to the Pond Parcel where material with net Th-232 activity concentrations greater than the DCCL of 31.1 pCi/g was segregated on site and disposed off site as exempt material at the U.S. Ecology Grand View Idaho facility. BCM (material with net activity concentrations below 31.1 pCi/g Th-232) was placed in the Pond Parcel excavation as backfill. At the end of the decommissioning project, the backfilled excavations located within the FOA will be final graded and vegetated to minimize soil erosion and promote positive site drainage.

1.4 Final Status Surveys and Reporting

Final status surveys for the Thorium Remediation Project consists of three distinct elements: (1) surveys of the "open land areas" of the site including the excavation bottom surface soils for the Pond Parcel and FOA; (2) surveys of BCM placed in the Pond Parcel excavations; and (3) surveys of structural surfaces. Final status surveys are completed prior to the backfilling of any Pond Parcel or FOA remediation excavation and during/following the placement of BCM in the Pond Parcel. The survey unit acceptance criteria developed in the DP are applicable to the entire site. Thus, if each survey unit meets the acceptance criteria, the dose for the entire site will be less than the release criteria of 25 mrem/yr.

The Final Status Survey Report is being submitted to NRC to address the survey units completed to date for the Thorium Remediation Project. The layout of this report is as follows:

- Volume I – Pond Parcel Excavation Bottom Survey Units Kaiser-FSS-001 through Kaiser-FSS-024 (Submitted March 2006)
- Volume II – Former Operational Area Excavation Survey Units Kaiser-FSSFOA-001 through Kaiser-FSSFOA-009 (Submitted March 2006)
- Volume III – Pond Parcel Backfill (BCM) Survey Units Kaiser_FSSB-001 through Kaiser-FSSB-009 (Submitted March 2006)
- Volume IV – Pond Parcel Excavation Bottom Survey Units Kaiser-FSS-025 through Kaiser-FSS-030 (Submitted June 2006)
- Volume V – Pond Parcel Backfill (BCM) Survey Units Kaiser-FSSB-010 through Kaiser-FSSB-15 (Submitted July 2006)
- Volume VI – Final Project Documentation - Site Drawings, Final Status Survey Quality Assurance Analytical Data, and Post-Remediation Final Survey Activities and Results (to be submitted at the end of Thorium Remediation Project)

Volumes I through V of the Final Status Survey Report contain individual sub-reports that provide final status survey results for a particular survey unit. These five volumes also contain independent chapters describing the specific type and/or area of survey,

applicable acceptance criteria and survey protocols, and a summary of survey results as well as supporting figures, tables, and attachments.

1.4.1 Pond Parcel and FOA Excavation Bottom Surveys and Reporting

Final status surveys associated with the Pond Parcel and FOA excavation bottoms are conducted through a progression of Class 1 survey units. Survey units typically consist of excavation bottom surface soil and associated side walls, elevated soil areas (if left in-place), and embedded structures (if encountered and left in-place). The final status survey of excavation bottom survey units typically consists of a gross gamma scan of the exposed surface soil of the unit and systematic soil sampling. Additional scanning and soil sampling are included for each elevated measurement comparison (EMC) performed for elevated areas left in-place. Embedded structures (typically small pipes and concrete) are surveyed for total alpha contamination (when possible) and removable alpha contamination.

Compliance with survey unit acceptance criteria is demonstrated by comparison of the average residual contamination for each survey element (excavation bottom soil, elevated areas, and embedded structures) to the appropriate acceptance criteria value and a sum of fractions for each survey unit is also calculated. The sum of fractions is a very conservative assessment of the survey unit. Summing the fractions ensures the survey unit and the entire site will be a small fraction of 25 mrem/yr (the release criterion) when the actual as-left dose assessment is complete. Systematic final status survey data are also evaluated using the Wilcoxan Rank Sum Test procedure.

Final status surveying and reporting have been completed for all 30 Pond Parcel excavation bottom survey units. **Volume I** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSS-001 through Kaiser-FSS-024. **Volume IV** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSS-025 through Kaiser-FSS-030. One of the 30 excavation bottom survey units (Kaiser-FSS-001) consisted of an embedded structure encountered (a buried concrete spillway) during the removal of radiologically impacted soil. A discussion of the appropriate survey unit acceptance criteria and surveying protocol for the Pond Parcel excavation bottom survey units is also presented in **Volumes I and IV** of this **Final Status Survey Report.**

Final status surveying and reporting have been completed for all 9 FOA excavation survey units. **Volume II** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSSFOA-001 through Kaiser-FSSFOA-009. Three of the 9 FOA excavation survey units consisted only of embedded structures (retaining walls) that were encountered during the removal of radiologically impacted soil located adjacent to the structures. A discussion of the appropriate survey unit acceptance criteria and surveying protocol for the FOA excavation survey units is also presented in **Volume II** of this **Final Status Survey Report.**

1.4.2 Pond Parcel Excavation Backfill Units (BCM) Surveys and Reporting

As with the Pond Parcel excavation bottoms, final status surveys associated with the Pond Parcel excavation backfill units (BCM) are conducted through a progression of Class 1 survey units. Typically a unit of BCM is placed in a portion(s) of a pond parcel excavation bottom(s) associated with a defined excavation bottom final status survey unit(s). Backfill units are completed through the placement of typically four to eight continuous layers (2-foot compacted lift depth) of BCM in a defined area. The final status survey of excavation backfill units consists of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit. Compliance with survey unit acceptance criteria is demonstrated by comparison of the average residual contamination for the survey unit to the appropriate acceptance criteria value. Systematic soil core sampling data are also evaluated using the Wilcoxan Rank Sum Test procedure.

Final status surveying and reporting have been completed for all 15 Pond Parcel excavation backfill survey units (Survey Units Kaiser-FSSB-001 through Kaiser-FSSB-015). **Volume III** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSSB-001 through Kaiser-FSSB-009. **Volume V** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSSB-010 through Kaiser-FSSB-015. A discussion of the appropriate survey unit acceptance criteria and surveying protocol for the Pond Parcel excavation backfill units is also presented in **Volumes III and IV** of this **Final Status Survey Report.**

1.4.3 Final Status Survey QA Program

The final status survey QA program implemented for the Thorium Remediation Project includes QA functions that cover aspects of data collection, including both field radiation instrument surveys, and soil and smear sampling for laboratory analysis, through the preparation of the documentation of the results. Applicable field radiation instrument final status survey QA data for each survey unit is provided in **Appendix A to Volumes I through V of this Final Status Survey Report.** Analytical QA data for the final status surveys will be documented in **Volume VI** of this Final Status Survey Report to be submitted at the end of the remediation project.

1.4.4 Final Project Documentation

Final project documentation to be submitted in **Volume VI** of the Final Status Survey Report will consist of the following:

- A completed NRC Form 314, Certificate of Disposition of Materials
- As-Left Condition Drawings illustrating the horizontal extent and bottom elevation grade of the Pond Parcel excavation, horizontal extent and top elevation grade of the BCM, and final elevation grade of the backfilled Pond Parcel excavation. Supporting thickness maps and cross-sections will be included to

document that the minimum soil cover thickness requirement of 10 feet for the project has been met.

- Final Status Survey Quality Assurance Analytical Data (See **Section 1.4.3** above).
- Post Operational (Remediation) Final Status Survey Results – Post operational final status surveys consist of radiological surveys using portable instrumentation and sampling, if necessary, of site areas where potential radiological materials may have been handled or stored during the Thorium Remediation Project (such as the water storage tank area, the material segregation/storage areas, and the railcar loading area).

1.4.5 Final Dose Assessment

A bounding dose assessment based on the maximum activity concentration and minimum soil cover requirement has been completed and is presented in **Appendix E** of **Volume III** of this **Final Status Survey Report**. The resulting maximum dose is 1.33 mrem/yr.

Final Status Survey Report
Volume V - Pond Parcel Excavation Backfill Units
Survey Units Kaiser-FSSB-010 through Kaiser-FSSB-015
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
July 12, 2006

2.0 INTRODUCTION

This volume of the Final Status Survey Report presents the results of Pond Parcel excavation backfill unit final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility **(Figure 1)**. Final status surveys associated with the Pond Parcel backfill units are being conducted through a progression of Class 1 survey units. Typically a unit of Below Criteria Material or BCM (less than 31.1 net pCi/g Th-232 material) is placed in a portion(s) of a pond parcel excavation bottom(s) associated with a defined excavation bottom final status survey unit(s). Backfill units are completed through the placement of typically four to eight continuous layers (2-foot compacted lift depth) of BCM. The final status survey of excavation backfill units consists of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit.

Final status surveying and reporting have been completed for all 15 Pond Parcel excavation backfill survey units (Survey Units Kaiser-FSSB-001 through Kaiser-FSSB-015). The final status survey results for Survey Units Kaiser-FSSB-001 through Kaiser-FSSB-009 were documented in Volume III of the Final Status Survey Report (March 2006). This volume of the Final Status Survey Report documents the final status survey results for Survey Units Kaiser-FSSB-010 through Kaiser-FSSB-015 **(Figure 3)**. Specifically, this volume of the report contains 6 individual sub-reports (BCM-010 through BCM-015), each documenting the final status survey results for a particular survey unit.

The remaining chapters of this volume presents the site release criteria for the Tulsa, Oklahoma facility and the acceptance criteria to be used to clear survey units **(Chapter 3.0)**, an overview of the surveying protocol for the Pond Parcel excavation backfill survey units **(Chapter 4.0)**, and a summary of findings relative to the final status survey of Pond Parcel excavation backfill Survey Units Kaiser-FSSB-010 through Kaiser-FSSB-015 **(Chapter 5.0)**. Supporting appendices to this volume of the Final Status Survey Report include the following:

- **Appendix A** – Survey Instrument Quality Assurance/Quality Control (QA/QC) Documentation
- **Appendix B** – Chapter 14.0 of the Decommissioning Plan (September 2005 Revision)
- **Appendix C** – Evaluation of Survey Unit Analytical Results, Wilcoxon Rank Sum Test
- **Appendix D** – Onsite Cave Counter Calibration and Soil Sample Results

3.0 FINAL STATUS SURVEY ACCEPTANCE CRITERIA

3.1 Site Release Criteria and Survey Unit Acceptance Criteria

The **site release criteria** for the Kaiser Tulsa, Oklahoma facility, as presented in the DP are:

"The site will be remediated in accordance with decommissioning criteria of Subpart E, Radiological Criteria for License Termination of 10 CFR Part 20, Standards of Protection Against Radiation. Specifically, Subpart E, 10 CFR 20.1402, Radiological Criteria for Unrestricted Use, allows release of a site for unrestricted use if the residual radioactivity distinguishable from background results in a TEDE to an average member of the critical group that does not exceed 25 mrem/yr and the residual radioactivity has been reduced to levels that are ALARA."

In regards to **acceptance criteria** to be used to clear survey units the DP continues:

"Dose modeling is used to estimate the TEDE to the average member of the critical group (that group reasonably expected to receive the greatest exposure to residual radioactivity for any applicable circumstances). The concentration of residual radioactivity (per radionuclide) distinguishable from background that, if distributed uniformly throughout a survey unit, results in a TEDE of 25 mrem in 1 year to an average member of the critical group is the single-radionuclide $DCGL_W$."

Two factors complicate the application of $DCGL_W$ acceptance criteria at the Kaiser Tulsa, Oklahoma facility. The first is the presence of multiple radionuclides, specifically, Th-232, Th-228 and Ra-228 from the thorium decay series and Th-230, Ra-226 and Pb-210 from the uranium decay series. Each radionuclide has a $DCGL_W$ value corresponding to the 25 mrem TEDE criteria. When multiple radionuclides are present, compliance may be demonstrated by a sum of fractions calculation over the entire series of radionuclides or the use of a surrogate value to represent 25 mrem TEDE for the entire mix of radionuclides presents. The activity concentration of Th-232 in units of pCi/g has been established as the surrogate acceptance criteria for surveys of soil and soil-like material. Use of Th-232 as a surrogate for soil surveys is detailed in the DP. Likewise gross alpha activity has been established as the surrogate acceptance criteria for surveys of structural surfaces. The use of gross alpha as a surrogate for structure surveys is detailed in the Technical Addendum to the Decommissioning Plan and Addendum, Revised Structural Surface Acceptance Criteria (May 2005).

The second factor is the presence of three distinct survey elements onsite. In addition to the exposed surface soil of the excavated open land areas and surfaces of structures remaining onsite, a third survey element is present as a result of the remedy provided in the DP. In developing the remedial action plan, a derived cutoff concentration level (DCCL) of 31.1 net pCi/g Th-232 has been determined. This value represents the dividing line concentration between material which must be exported to an off-site disposal facility and material which can remain onsite under an unrestricted release scenario. The dose assessment presented in Chapter 5.0 of the DP demonstrates that unrestricted release dose levels can be achieved when material below the DCCL are returned to the excavation. The average concentration of BCM

remaining on site is termed in the DP as the Average Derived Concentration Level ($ADCL_W$). Dose-based criteria have been established for the Kaiser Tulsa, Oklahoma facility for three distinct survey elements: (1) surveys of the open land areas of the site including the FOA and the Pond Parcel excavation bottoms; (2) surveys of the Pond Parcel excavation backfill (BCM) units; and (3) surveys of structural surfaces.

Finally, for each survey element acceptance criteria there are additional criteria provided to address small areas of elevated activity calculated from area factors (AF) provided in the DP and the technical addendum to the DP. The elevated measurement comparison (EMC) criteria are referred to as $DCGL_{EMC}$ values.

The inputs and assumptions used to derive element specific acceptance criteria are not the same, but rather are conservative for the specific survey element. The stand-alone acceptance criteria and key inputs/assumptions are:

- **Excavation Bottom Surface Soil $DCGL_W$** – 3.0 net pCi/g of Th-232 over the entire survey unit. Inputs/assumptions include 6-inch contaminated zone thickness and no cover.
- **Excavation Bottom Surface Soil $DCGL_{EMC}$** – 37.5 net pCi/g of Th-232 over 1 m^2. Additional values are provided for increasing survey areas. Inputs/assumptions are the same as excavation bottom surface soil except for area.
- **Below Criteria Material (BCM) DCCL** – 31.1 net pCi/g of Th-232 over the entire survey unit. Inputs/assumptions include a 3.31-meter contaminated zone thickness and minimum 3.05-meter (10 feet) clean layer of import borrow (soil) material.
- **Below Criteria Material (BCM) $ADCL_{EMC}$** – 87.5 net pCi/g of Th-232 over 1 m^2. Additional values are provided for increasing survey areas. Inputs/assumptions are the same as BCM except for area.
- **Structure Surface Total Contamination GA-DCGL** – 944 net dpm/100cm^2 gross alpha over 100 m^2. Inputs/assumptions include 100 m^2 of surface area and a removable fraction of 0.1.
- **Structure Surface Removable Contamination GA-DCGL** – 94.4 net dpm/100cm^2 gross alpha over 100 m^2. Inputs/assumptions are the same as structure surface total contamination.
- **Structure Surface Total Contamination GA-$DCGL_{EMC}$** – 92,700 net dpm/100cm^2 gross alpha over 1 m^2. Inputs/assumptions are the same as structure surface total contamination except for area.
- **Structure Surface Removable Contamination GA-$DCGL_{EMC}$** – 9,270 net dpm/100cm^2 gross alpha over 1 m^2. Additional values are provided for increasing survey areas. Inputs/assumptions are the same as structure surface total contamination except for area.

3.2 Open Land Area Acceptance Criteria

For surveys of the open land surface (excavation bottom and side walls) remaining after excavation of radiologically impacted material from the Pond Parcel and FOA, a surrogate net Th-232 activity concentration of 3.0 pCi/g is the applicable $DCGL_W$ value. **Table 3-1** presents area factors (based upon MARSSIM guidance) to be used for elevated measurement comparisons

(EMC) and to determine sampling requirements in situations where the scan instrument's minimum detectable concentration (MDC) is greater than the $DCGL_W$. The $DCGL_{EMC}$ values applicable to the open land areas of the site area are calculated by multiplying the $DCGL_W$ by the area factors presented in **Table 3-1**. $DCGL_{EMC}$ values are presented in **Table 3-2**.

$$DCGL_{EMC} = \text{Area Factor} * DCGL_W$$

Table 3-1 – Open Land Areas Area Factors

Area Factors									
Radio-nuclide	1 m^2 (11 ft^2)	3 m^2 (32 ft^2)	10 m^2 (108 ft^2)	30 m^2 (323 ft^2)	100 m^2 (1,076 ft^2)	300 m^2 (3,229 ft^2)	1,000 m^2 (10,764 ft^2)	3,000 m^2 (32,292 ft^2)	10,000 m^2 (107,639 ft^2)
Th-232	12.5	6.2	3.2	2.3	1.8	1.5	1.1	1.0	1.0

Table 3-2 - $DCGL_{EMC}$ Values for Open Land Areas

$DCGL_{EMC}$ (pCi/g)									
Radio-nuclide	1 m^2 (11 ft^2)	3 m^2 (32 ft^2)	10 m^2 (108 ft^2)	30 m^2 (323 ft^2)	100 m^2 (1,076 ft^2)	300 m^2 (3,229 ft^2)	1,000 m^2 (10,764 ft^2)	3,000 m^2 (32,292 ft^2)	10,000 m^2 (107,639 ft^2)
Th-232	37.5	18.6	9.6	6.9	5.4	4.5	3.3	3.0	3.0

3.3 Below Criteria Material (BCM) Acceptance Criteria

For surveys of the BCM placed in Pond Parcel excavations, a surrogate net Th-232 activity concentration of 31.1 pCi/g is the DCCL value. **Table 3-1** presents area factors (based upon MARSSIM guidance) to be used for EMCs of open land areas and to determine sampling requirements in situations where the scan instrument's MDC is greater than the DCCL. (The use of the open land area areas factors is conservative for surveys of the BCM.) For the BCM used as Pond Parcel backfill, the ADCL value was multiplied by the area factors presented in **Table 3-1** and the results are presented in **Table 3-3**.

$$ADCL_{EMC} = \text{Area Factor} * ADCL$$

However, since the BCM can be as high as 31.1 net pCi/g Th-232, the EMC is only applicable to concentrations exceeding 31.1 pCi/g Th-232 above background. The ADCL value of 7 pCi/g of Th-232 was conservatively used to establish elevated measurement criteria for BCM greater than 31.1 pCi/g Th-232 above background, to maintain the average concentration of the backfill material ALARA.

Table 3-3 - $ADCL_{EMC}$ Values for Pond Parcel BCM Units

	$ADCL_{EMC}$ (pCi/g)								
Radio-nuclide	1 m^2 (11 ft^2)	3 m^2 (32 ft^2)	10 m^2 (108 ft^2)	30 m^2 (323 ft^2)	100 m^2 (1,076 ft^2)	300 m^2 (3,229 ft^2)	1,000 m^2 (10,764 ft^2)	3,000 m^2 (32,292 ft^2)	10,000 m^2 (107,639 ft^2)
Th-232	87.5	43.4	22.4	16.1	12.6	10.5	7.7	7.0	7.0

3.4 Structures Acceptance Criteria

For surveys of structures remaining onsite, 944 dpm/100cm^2 of total alpha contamination is the applicable GA-DCGL value. **Table 3-4** presents area factors (based on MARSSIM guidance) to be used for elevated measurement comparisons and to determine sampling requirements in situations where the scan instrument's MDC is greater than the GA-DCGL. The appropriate $GA\text{-}DCGL_{EMC}$ values are calculated by multiplying the GA-DCGL by the area factors presented in **Table 3-4** and the results are presented in **Table 3-5.**

$$GA\text{-}DCGL_{EMC} = \text{Area Factor} * GA\text{-}DCGL$$

Table 3-4 Structures Area Factors

	Area Factors								
GA-DCGL	1 m^2	2 m^2	3 m^2	4 m^2	5 m^2	10 m^2	20 m^2	30 m^2	100 m^2
	98.2	49.2	32.9	24.7	19.8	9.91	4.97	3.32	1.00

Table 3-5 $GA\text{-}DCGL_{EMC}$ Values Structures

	$DCGL_{EMC}$ (dpm/100cm^2)								
GA-DCGL	1 m^2	2 m^2	3 m^2	4 m^2	5 m^2	10 m^2	20 m^2	30 m^2	100 m^2
	9.27E+04	4.64e+04	3.10E+04	2.33E+04	1.87E+04	9.36E+03	4.69E+03	3.13E+03	9.44E+02

The criteria for total alpha contamination corresponds to 25 mrem/yr TEDE based on the assumption of less than 10% of the total contamination is removable. Compliance for structures is also demonstrated by taking smear samples of 100 cm^2 of surface area and comparison of the gross alpha count result to 10% of the applicable total contamination GA-DCGL.

3.5 Interim Sum of Fractions for Pond Parcel Excavation Bottom and FOA Excavation Surveys

The inputs and assumptions used to derive the DCCL value for BCM reflect the projected as-left condition of the site. This configuration is very conservative for all of the other survey elements since the DCGL derivation was based on no soil cover. When the layers of BCM and a minimum 10 foot clean cover are placed on top of the excavation surface soil and embedded structures, the dose from these survey elements are reduced to 0 mrem, since the great majority of exposure from these elements depends on direct contact or proximity to the element. Once the

final as-left configuration of the site has been determined through final status and land surveys, a final as-left dose assessment will be completed to demonstrate compliance with the DP release criteria of 25 mrem/yr TEDE.

Survey unit compliance is demonstrated by comparison of the average residual contamination for each survey element present to the appropriate acceptance criteria value and a sum of fractions for each survey unit is calculated. The sum of fractions is a very conservative assessment of the survey unit. Summing the fractions ensures the survey unit will be a small fraction of 25 mrem/yr (the release criteria) when the actual as-left dose assessment is complete. A bounding as-left condition dose assessment is included in **Volume III, Appendix E** of this Final Status Survey Report.

4.0 FINAL STATUS SURVEY PROTOCOL

4.1 Generic Survey Protocol

Survey units for the Thorium Remediation Project are evaluated to determine whether the average residual radioactivity concentration in a particular survey unit as a whole is below the applicable acceptance criterion concentration, i.e., the $DCGL_W$, GA-DCGL or DCCL. The final survey protocol uses both systematic grid sampling to determine this average radionuclide concentration in a survey unit in conjunction with scans to identify elevated areas of residual radioactivity. At least the minimum number of samples (N/2) is taken in each survey unit. Since the radionuclides of interest at the Tulsa, Oklahoma facility also occur naturally in background, survey unit final status survey data are compared to data from a reference area under what is known as a "two-sample test," or the Wilcoxon Rank Sum (WRS) Test. Application of the WRS Test procedure is described in **Appendix C** of this volume of the Final Status Survey Report.

When using the WRS Test, the minimum number of samples (N/2) is the number of samples required in the survey unit and in the reference background area. Hence "N" is the total number of samples required to complete the WRS Test. (Please note: N is often used to represent the number of samples in the survey unit or in the reference area also.) Paramount to determining the minimum number of samples is the determination of the relative shift, delta over sigma (Δ/σ). Delta is equal to the DCGL minus the lower-bound gray region (LBGR) value. The LBGR value is arbitrarily set at one-half the DCGL value to start the determination. Sigma is an estimate of the variability in a set of sample analysis results from a survey unit.

A random-start triangular pattern, or grid, is used in Class 1 and Class 2 survey units to locate the sample points. For Class 3 survey units, the samples are located randomly or at the discretion of the Data Manager. The distance between each sampling grid node, L, is determined by the following equation:

$$L = \sqrt{\frac{A}{0.866N}}$$

In the above equation, A is the survey unit area to be covered by the grid pattern and N (equal to N/2 for WRS testing) is the number of samples required for that survey unit. The random start point (X and Y coordinates) is selected using a random number generator ("RAND") function in the Microsoft computer application *Excel*©. Sample points are identified in the field by flags or other means using a global positioning system (or equivalent locating tool) to locate each grid node.

The routine method (of determining N) described above presumes that the actual scan MDC is less than or equal to the required scan MDC, i.e., there is sufficient scan sensitivity available to detect small areas of elevated activity. (The derivation of various scan MDCs is presented in **Section 4.2.**) For the infrequent situations where the actual scan MDC exceeds the required scan MDC (acceptance criteria for the survey unit), the alternate method for calculating the required number of samples N may be used. This alternate method is described in Section 5.5.2.4 of

MARSSIM and involves the calculation of an area factor corresponding to the actual scan MDC as follows:

$$AreaFactor = \frac{ScanMDC(actual)}{DCGL_W}$$

(Depending on the survey unit, *DCCL* or *GA-DCGL* is substituted for $DCGL_W$ in the above equation.) The size of an area of elevated radioactivity corresponding to this area factor is interpolated from the appropriate area factor tables contained in **Chapter 3.0** and divided into the survey unit area to determine the alternate number of sample locations N_1. If N_1 exceeds the value assigned to N, an alternate spacing L_1 for the systematic sampling grid is calculated using the equation:

$$L_1 = \sqrt{\frac{A}{0.866N_1}}$$

The corresponding height (h) of the equilateral triangle with side length equal to L (or L_1) is calculated using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$.

4.2 Final Status Survey Instrumentation

4.2.1 Soil Survey Instrumentation

The MARSSIM framework for determining the MDC for field instrument scanning activities is based on the premise that there are two stages of scanning. That is, surveyors do not make decisions on the basis of a single indication; rather, upon noting an increased number of counts, they pause briefly and then decide whether to move on or take further measurements. Thus, scanning consists of two components: continuous monitoring and stationary sampling. Accordingly, field instrument surveyor scan MDCs, $MDCR_S$, are calculated to control the occurrence of Type I (false negative) and Type II (false positive) errors using the following MARSSIM equation:

$$MDCR_S = \frac{MDCR}{\sqrt{p\varepsilon}}$$

where *MDCR* is the minimum detectable count rate (cpm), p is the surveyor efficiency (estimated in MARSSIM to be between 0.5 and 0.75; the value of 0.5 results in a more conservative $MDCR_S$ calculation and, therefore, will be used), and ε is the instrument efficiency (cpm per μR/hr; Table 6.4 of NUREG-1507). In addition:

$$MDCR = s_i\left(\frac{60}{i}\right)$$

$$s_i = d'\sqrt{b_i}$$

where s_i (counts) is the minimal number of net source counts required for a specified level of performance for the counting interval i (seconds); d' is the index of sensitivity; and b_i is the number of background counts in the interval. Index of sensitivity d' values are listed in MARSSIM Table 6.5 based on the proportions for required true positive and tolerable false positive occurrence rates. The index of sensitivity value selected for initial use at the Kaiser, Tulsa facility is 1.38, corresponding to a true positive proportion of 0.95 and a false positive proportion of 0.60.

Typical calculated Th-232 scan MDCs for a survey instrument equipped with 2-inch x 2-inch NaI (2x2) detector using this MARSSIM two-stage scanning framework are summarized below in **Table 4-1** for increasing background count rates.

Table 4-1 Typical Soil Scan MDCs for Th-232 Detection Using a 2 × 2 NaI Detector[a]

Bkg (cpm)	i (sec)	P -	ε (cpm per µR/hr)	D' -	s_i (counts)	$MDCR$ (ncpm)	$MDCR_S$ (ncpm)	CF[b]	*Scan MDC*[c]	
									µR/hr	pCi/g
5,000	1	0.5	830	1.38	13	756	1069	0.99	1.29	1.3
10,000					18	1069	1512		1.82	1.8

a. Th-232 in equilibrium with progeny uniformly distributed in a source thickness of 6 inches.

b. Conversion factor (pCi/g per µR/hr) taken from NUREG-1507, modeled using *MicroShield*. CF = Scan MDC (pCi/g) / Scan MDC (µR/hr)

c. *Scan MDC* (µR/hr) = $MDCR_S/\varepsilon$ and *Scan MDC* (pCi/g) = $(MDCR_S/\varepsilon)CF$

When scanning soil, the detector is held close to the ground (1 to 2 inches) and moved in a serpentine pattern. A scan rate of approximately 0.5 m per second is used reflecting the natural pace of the technician walking with the equipment swinging the detector a width of 1 meter in a serpentine pattern. Estimates of scan speed are provided for each soil survey unit for which the GPS/data logger system was used. The scan speed is estimated by dividing the total area surveyed by the number of 1 or 2 second interval gross gamma results recorded.

4.2.2 Structure Survey Instrumentation

Measurements of alpha activity are used to show compliance with the structural surface total and removable contamination acceptance criteria in units of dpm/100 cm^2. Scanning for gross alpha activity is used as part of final status surveys of structural surfaces to ensure elevated areas of activity are identified. In addition, static counts at predetermined sample points are used to assess total alpha contamination of structural surfaces. The following instrument is being used for the Thorium Remediation Project to survey structural surfaces:

Meter Manufacturer and Model	Detector Manufacturer and Model	Detector Type	Use
Ludlum 2221	Ludlum 43-68 Gas Proportional	Gas Proportional	Final status survey scans and static counts for total alpha contamination measurements

Structure survey instruments are evaluated and controlled to verify that MDCs of less than the $DCGL_w$ for direct measurements and/or scanning measurements are routinely achieved. Field instrument scan MDCs are calculated to control the occurrence of Type I (false negative) and Type II (false positive) as discussed in the following subsections.

4.2.2.1 Alpha Scan

For a typical alpha background level of less than 3 cpm, the probability of detecting a single count while passing over the contaminated area is:

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}}$$

where:

$P(n \geq 1)$ = probability of observing a single count,
G = activity (dpm),
E = 4π detector efficiency (cpd),
d = width of detector in direction of scan (cm), and
v = scan speed (cm/s).

The value of G is increased until the corresponding probability equaled the desired confidence level, e.g., 95 percent. **Table 4-2** summarizes the calculation of alpha scan MDCs for the 4π detector alpha efficiencies of the instruments used. The resulting values of G (dpm) are significantly below the GA-DCGL value of 944 dpm/100cm^2.

Table 4-2 Typical Structure Scan MDCs for Gross Alpha Detection

G (dpm)	d (cm)	E (cpm)	v (cm/s)	P (-)
380	11.7	0.1618	3.90	0.95
550	11.7	0.1618	5.9	0.95
720	11.7	0.1618	7.80	0.95
1080	11.7	0.1618	11.7	0.95

4.2.2.2 Alpha Static Counts

Minimum counting times for static counts of total and removable contamination will be chosen to provide an MDC that is a fraction (25 to 75 percent) of the survey unit-specific acceptance criteria. MARSSIM equations have been modified to convert to units of dpm/100 cm^2. Count times are determined using the following equation. Static counting MDCs at a 95 percent confidence level are calculated using the following equation which is an expansion of NUREG-1507, Equation 6-7 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100}}$$

where:

MDC_{static} = minimum detectable concentration level in dpm/100 cm^2,
B_R = background count rate in counts per minute,
t_B = background count time in minutes,
t_S = sample count time in minutes,
A = detector probe physical (active) area in cm^2, and
E_{tot} = total detector efficiency for radionuclide emission of
= E_i x E_s,
where:
E_i = 2π instrument efficiency in counts per disintegration (cpd) and
E_s = source (or surface contamination) efficiency.

Note: E_s values can be determined or the default values provided in NUREG-1507 can be used as follows: 0.25 for all alpha energies and beta maximum energies between 0.15 and 0.4 MeV, 0.5 for all beta maximum energies greater than 0.4 MeV.

Table 4-3 contains example static alpha MDC calculation results for structural surfaces.

Table 4-3 Structural Surface Alpha Static MDC

Background Gross Alpha Count Rate (cpm)	Background Count Time (min)	Static Measurement Count Time (min)	Total Detector Efficiency	Detector Probe Area (cm^2)	Static MDC (dpm/100cm^2)
0.5	1	1	0.040	126	123
1.0	1	1	0.040	126	150
1.0	5	5	0.040	126	52.6
2.0	5	5	0.040	126	69.5

4.3 Laboratory Analysis

Final status survey analytical laboratory services for the Thorium Remediation Project are being provided by Outreach Laboratory (Outreach) of Broken Arrow, Oklahoma. Final status survey samples consist of soil media samples and smear samples of removable alpha contamination.

Final status survey soil samples are analyzed for Th-232 activity concentration in units of pCi/g via gamma spectroscopy. The samples are counted by the laboratory as received, i.e., they are not dried and/or ground. The MDC value required for each gamma spectroscopy analysis is 25 percent of the release criteria for Th-232. Characterization survey results confirm that Th-232 is in secular equilibrium with its short-lived progeny Ac-228 and Th-228. Outreach infers Th-232 activity from the high energy/high yield gamma emitted by progeny of the thorium decay series, e.g., Actinium-228 (secular equilibrium progeny) high energy gamma line (911 keV). The Th-228 activity is calculated by multiplying the Th-232 activity by 1. The Th-230 activity is calculated by multiplying the Th-232 activity by 3.5.

The laboratory's analytical results are reported to include the activity, the 95 percent confidence level uncertainty (2-sigma error), and the MDC all in the same units of the sample analyzed.

To exclude the bias introduced when grouping analytical results containing "less than" values, the laboratory has been instructed to report observed counting data when reporting results that are below the critical level L_C (and thus "not detected") established for each analysis.

4.4 Open Land Area Survey Protocol

4.4.1 Minimum Number of Samples Determination

The estimate of sigma used for the Thorium Remediation Project is based on the standard deviation of the Th-232 activity measured in survey units during the ALRP final status survey (0.42). Using the $DGCL_w$ value of 3.0 pCi/g of Th-232, Δ is equal to 3.0 - 1.5, or 1.5. Delta divided by the sigma of 0.42 results in a relative shift of 3.57 which is rounded to 3.5 for the purpose of determining the required number of samples. The corresponding minimum number of samples looked up in Table 5.3 of MARSSIM is 9.

4.4.2 Open Land Area Gross Gamma Scan Survey

Portable survey meters consisting of 2-inch by 2-inch sodium iodide (NaI) detectors (Ludlum Model 44-10) coupled with scaler instruments (Ludlum Model 2221) are used to perform gross gamma scans (to identify elevated areas). Typically, the portable survey meters are also coupled to a Global Positioning System (GPS) unit and a data logger to provide electronic downloads of coordinates and associated gross gamma count rates in units of counts per minute (cpm).

Per Section 5.3.3 of MARSSIM, scanning is used to identify locations within the survey unit that exceed the investigation level. For Class 1 survey units, the investigation level is the derived concentration guideline elevated measurement criteria ($DCGL_{EMC}$) value for the area scanned. The $DCGL_{EMC}$ values applicable to the open land areas of the site are calculated by multiplying

the $DCGL_W$ by the area factors presented in **Chapter 3.0.** $DCGL_{EMC}$ values are also presented in **Chapter 3.0.**

The scan MDC and the scanning thresholds in measurement units of net counts per minute (ncpm) are calculated in accordance with MARSSIM and NUREG-1507. These values are summarized below in **Table 4-5** for a maximum background of 50,000 cpm and increasing survey areas (A). The first line (A = 0.25 m^2) is the default area used to demonstrate the calculation of scan MDC and the derivation of the conversion factor (CF in units of pCi/g or μR/h) in NUREG-1507. However, surveys of an area this small are not applicable to final status, open land area surveys. The increasing areas presented in the table correspond to the approved area factors (DP) and result in scan thresholds for detection of both elevated areas (Fail $DCGL_{EMC}$) and complete survey units with activity concentration greater than the $DCGL_W$ (Fail $DCGL_W$). The CF's for increasing areas were derived using the identical inputs of the NUREG-1507 derivation changing only the area.

In addition to the derived scan thresholds, scan data are evaluated against empirical data gathered in the field. For example, soil samples are collected at biased locations (highest scan count rate) and screened on site for Th-232 activity concentration corresponding to the high count rate. All of these factors (derived thresholds, empirical thresholds, and biased samples) are used to identify elevated areas and to release the survey unit for final sampling. The threshold values provided are theoretical, depend on counting geometry and other factors that cannot be controlled in the field, and are used to aid identifying elevated areas that may require additional remediation or application of the elevated measurement comparison.

Table 4-5 – Open Land Areas Scan MDC and Threshold Values

A Area (m^2)	$DCGL_{EMC}$ (pCi/g)	B (cpm)	CF (pCi/g / μR/h)	Scan MDC (pCi/g)	Fail $DCGL_{EMC}$ (ncpm)	Fail $DCGL_W$ (ncpm)
0.25	N/A	50,000	0.99	4.0	N/A	2,515
1	37.5	50,000	0.62	2.5	50,578	4,046
3	18.6	50,000	0.51	2.1	30,212	4,873
10	9.6	50,000	0.46	1.9	17,227	5,383
30	6.9	50,000	0.45	1.8	12,851	5,588
100	5.4	50,000	0.44	1.8	10,250	5,695
300	4.5	50,000	0.43	1.8	8,624	5,749
1000	3.3	50,000	0.43	1.8	6,360	5,782
3000	3.0	50,000	0.43	1.7	5,799	5,799

4.4.3 Open Land Area Soil Sampling

4.4.3.1 Systematic Final Status Survey Soil Sampling

Systematic soil samples are collected at locations determined through the use of a random start point and an equal-distant triangular grid in accordance with MARSSIM and the DP. Soil sample locations are demarcated in the field (using a GPS unit) and soil samples are collected at

the surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel.

4.4.3.2 Additional Biased and EMC Evaluation Soil Sampling

In addition to the systematic samples used to determine the average Th-232 activity concentration in the survey unit, other soil samples may be taken within a survey unit to help demonstrate compliance. At the discretion of the surveyor, biased samples are taken at high scan rate locations to help determine scan survey results. In addition, if small areas of elevated activity are identified, additional soil samples are taken at biased locations to aid in the elevated measurement comparison for the area.

4.4.3.3 Use of the On Site Cave Counter

Certain soil samples, e.g., biased and/or EMC samples collected as part of the final status survey process are screened for Th-232 activity concentration using an on site cave counter. The on site cave counter for the Thorium Remediation Project consists of a 2-inch by 2-inch NaI Ludlum Model 44-10 detector coupled with a Ludlum Model 2221 Scaler/Ratemeter instrument, mounted inside a shielded box with room for a standard soil sample container to be placed on the face (bottom, non-wire connecting end) of the detector. Two detectors (numbered NaI # 4 and NaI #8) have been used as part of the counter. The detectors were calibrated annually off-site by a qualified vendor to verify their response to high energy photons. The detectors, including their use as part of the counter, are utilized to obtain gross gamma readings from soil samples in units of counts per minute (cpm). The detector response is checked daily when in use to a Cs-137 source. Documentation of the on site cave counter calibration and the calculation of Th-232 activity concentration, 95% confidence level uncertainty, and the MDC, are presented in **Appendix D** of this volume of the Final Status Survey Report.

4.5 Structure Survey Protocol

Permanent structures (destined to remain on site) encountered during the implementation of the Thorium Remediation Project can be classified by type. The first type is termed "embedded structures" and consists of small pipes and remnants of previous structures uncovered during excavation activities. These structures consist of very small surface areas (< 1 or 2 m^2) and will be buried with BCM and/or clean fill based on the final site configuration. Measurements of total alpha contamination and smear samples of removable alpha contamination are taken on these structures and reported with the open land area survey unit for which they reside. The second type of structure is the large surface area (approaching 100 m^2) structure such as a concrete retaining wall. This type of structure constitutes a separate survey unit and is surveyed as such.

4.5.1 Minimum Number of Samples Determination

The estimate of sigma used for the Thorium Remediation Project is based on the standard deviation of a set of total alpha contamination results from the final status survey of the Flux Building (Survey Unit FB-001 Floor Surface: 45.9). Since the gross alpha activity concentration

of 944 dpm/100cm2 will be used as the DGCL-GA, Δ is equal to 944 - 472, or 472. Delta divided by the sigma of 45.9 results in a relative shift of 10.3. The minimum number of samples (looked up in Table 5.3 of MARSSIM) corresponding to alpha and beta error rates of 0.05 and a relative shift of 10.3 is 9.

4.5.2 Structure Surfaces Gross Alpha Scan Survey

Portable survey meters consisting of gas proportional detectors (Ludlum Model 43-68) coupled to alpha/beta scaler instruments (Ludlum Model 2360) are used wherever possible to perform scans (to identify elevated areas of alpha activity). Whenever the structure is too small or inaccessible for a gas proportional detector, surveys of gross gamma activity are performed using a 2-inch by 2-inch sodium iodide (NaI) detector (Ludlum Model 44-10) coupled with a scaler instrument (Ludlum Model 2221)

4.5.3 Systematic Measurements of Total and Removable Alpha Contamination

Systematic sample points are marked at locations determined through the use of a random start point and an equal-distant triangular grid in accordance with MARSSIM and the DP. Static measurements are taken at each sample point location to determine the total alpha contamination (in units of dpm/100cm^2). Smear samples representing 100cm^2 areas are also collected at the same sample point location to assess removable alpha contamination (in units of dpm/100cm^2). The smear samples are sent to Outreach for laboratory analysis.

For small embedded structures, static counts are taken to determine total alpha contamination (in units of dpm/100cm^2) at biased locations (highest scan result) when possible. Smear samples representing 100 cm^2 areas are also collected at the same sample locations and counted for removable alpha contamination by Outreach. In areas such as the interiors of small diameter piping, the gas proportional detectors typically can not be used for static measurements; therefore, only smear samples are taken to assess the removable alpha contamination.

4.6 BCM Unit Survey Protocol

4.6.1 Minimum Number of Samples Determination

The estimate of sigma used for the Thorium Remediation Project is based on an estimate of the variance of Th-232 activity concentrations of core composite samples of 4.4. Using the DCCL value of 31.1 pCi/g of Th-232, and a LBGR of 31.1/2, Δ is equal to 31.1 - 15.55, or 15.55. Delta divided by the sigma of 4.4 results in a relative shift of 3.5. The corresponding minimum number of samples looked up in Table 5.3 of MARSSIM is 9.

4.6.2 BCM Unit Gross Gamma Scan Survey

Portable survey meters consisting of 2-inch by 2-inch sodium iodide (NaI) detectors (Ludlum Model 44-10) coupled with scaler instruments (Ludlum Model 2221) are used to perform gross gamma scans (to identify elevated areas) for each 2-foot lift of placed BCM. Typically, the portable survey meters are also coupled to a GPS unit and a data logger to provide electronic

downloads of coordinates and associated gross gamma count rates in units of counts per minute (cpm).

Per Section 5.3.3 of MARSSIM, scanning is used to identify locations within the survey unit that exceed the investigation level. For Class 1 survey units, the investigation level is the derived concentration guideline elevated measurement criteria ($DCGL_{EMC}$) value for the area scanned. The $DCGL_{EMC}$ values applicable to the BCM survey units are calculated by multiplying the ADCL by the area factors presented in **Chapter 3.0.** $ADCL_{EMC}$ values are also presented in **Chapter 3.0.**

The scan MDC and the scanning thresholds in measurement units of net counts per minute (ncpm) are calculated in accordance with MARSSIM and NUREG-1507. These values are summarized below in **Table 4-6** for a maximum background of 50,000 cpm and increasing survey areas (A). The first line (A = 0.25 m^2) is the default area used to demonstrate the calculation of scan MDC and the derivation of the conversion factor (CF in units of pCi/g or μR/h) in NUREG-1507. However, surveys of an area this small are not applicable to final status, open land area surveys. The increasing areas presented in the table correspond to the approved area factors (DP) and result in scan thresholds for detection of both elevated areas (Fail $DCGL_{EMC}$) and complete surveys units with activity concentration greater than the $DCGL_W$ (Fail $DCGL_W$). The CFs for increasing areas were derived using the identical inputs of the NUREG-1507 derivation changing only the area.

In addition to the derived scan thresholds, scan data are evaluated against empirical data gathered in the field. For example, soil samples are collected at biased locations (highest scan count rate) and screened on site for Th-232 activity concentration corresponding to the high count rate. All of these factors (derived thresholds, empirical thresholds, and biased samples) are used to identify elevated areas and to release the survey unit for final sampling. The threshold values provided are theoretical, depend on counting geometry and other factors that cannot be controlled in the field, and are used to aid identifying elevated areas that may require additional remediation or application of the elevated measurement comparison.

Table 4-6 – BCM Scan MDC and Threshold Values

A Area (m^2)	$ADCL_{EMC}$ (pCi/g)	B (cpm)	CF (pCi/g / mR/h)	Scan MDC (pCi/g)	Fail $ADCL_{EMC}$ (ncpm)	Fail DCCL (ncpm)
0.25	N/A	150,000	0.99	7.0	N/A	26,074
1	87.5	150,000	0.62	4.3	118,016	41,946
3	43.4	150,000	0.51	3.6	70,495	50,516
10	31.1	150,000	0.46	3.3	55,808	55,808
30	31.1	150,000	0.45	3.1	57,924	57,924
100	31.1	150,000	0.44	3.1	59,034	59,034
300	31.1	150,000	0.43	3.1	59,602	59,602
1000	31.1	150,000	0.43	3.0	59,938	59,938
3000	31.1	150,000	0.43	3.0	60,118	60,118

4.6.3 BCM Unit Systematic Soil Core Sampling

Upon completion of the placement of a BCM unit, systematic soil core samples are collected at locations determined through the use of a random start point and an equal-distant triangular grid in accordance with MARSSIM and the DP. Soil core sample locations are demarcated in the field using a GPS unit. Soil core samples are collected through the entire layer of placed BCM. It should be noted that the entire length of each soil core from a BCM survey unit may not equal the total depth of the placed BCM due to the following:

- The bottom surface (grade) of each excavation bottom unit may not be level when a BCM unit is placed.
- The top surface of BCM in a unit may not be level based upon the site's final grade plan relative to maintaining the minimum 10 feet of clean cover soil.
- BCM units are placed in 2 foot lifts with sloping side walls. As a result, succeeding lifts become smaller in surface area (a core sample point may fall on the unit's sloped side walls).

Core segments of BCM (typically 3 feet in length) are scanned in the field in 1-foot increments. Each one foot increment is also characterized by a 1-minute static count of gross gamma activity. A composite sample representing each core segment is then prepared by combining each set of three 1-foot increments in a bucket and breaking up the cores. The final segment of core may be less than or greater than 3 feet depending on the point at which virgin material is encountered. A sample (usually between 500 and 800 grams) is taken from each composite and forwarded to Outreach for analysis of Th-232 activity concentration.

5.0 SUMMARY OF FINDINGS

This chapter of Volume V of the Final Status Survey Report presents a summary of the final status survey findings for Pond Parcel excavation backfill (BCM) Survey Units Kaiser-FSSB-010 through Kaiser-FSSB-015.

Final status survey activities for Pond Parcel excavation backfill Survey Units Kaiser-FSSB-010 through Kaiser-FSSB-015 consisted of a gross gamma scan of each placed lift of BCM and systematic soil core sampling upon completion of each BCM unit. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan of each lift (final as-left condition) for each survey unit did not indicate the presence of small areas (1 m^2) of elevated activity (greater than the DCCL for the site).
- The systematic core sample (composited by core segment) analytical results (net) for each survey unit were below the BCM surrogate value of 31.1 pCi/g net Th-232 activity concentration (DCCL).
- The systematic composite sample analytical results for each survey met the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).

A summary of the final status survey results by survey unit is provided below in **Table 5-1.**

Table 5-1 – Pond Parcel Excavation Backfill Final Status Survey Summary by Survey Unit

Survey Unit	Base Surface Area (m^2)	No. of Systematic Soil Cores	No. of Systematic Soil Core Composite Samples	Systematic Soil Core Sample Exceedance of DCCL Value	WRS Test Criterion Met	Elevated Area(s) Present	Survey Unit Meets DP Acceptance Criteria
Kaiser-FSSB-010	1,770	9	28	NO	YES	NO	YES
Kaiser-FSSB-011	1,754	11	22	NO	YES	NO	YES
Kaiser-FSSB-012	1,840	9	38	NO	YES	NO	YES
Kaiser-FSSB-013	1,620	9	28	NO	YES	NO	YES
Kaiser-FSSB-014	1,660	10	41	NO	YES	NO	YES
Kaiser-FSSB-015	1,820	9	40	NO	YES	NO	YES

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(3) USEPA 402-R-97-016, December 1997, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575.

(4) Earth Sciences Consultants, Inc., December 2001, Work Plan, Characterization Survey of the Operational Area, Former Kaiser Aluminum Specialty Products Facility, Tulsa, Oklahoma

(5) Penn Environmental & Remediation, Inc., May 2005, Technical Addendum to the Decommissioning Plan and Addendum Revised Structural Surface Acceptance Criteria, Thorium Remediation Project, Tulsa, Oklahoma, Kaiser Aluminum & Chemical Corporation.

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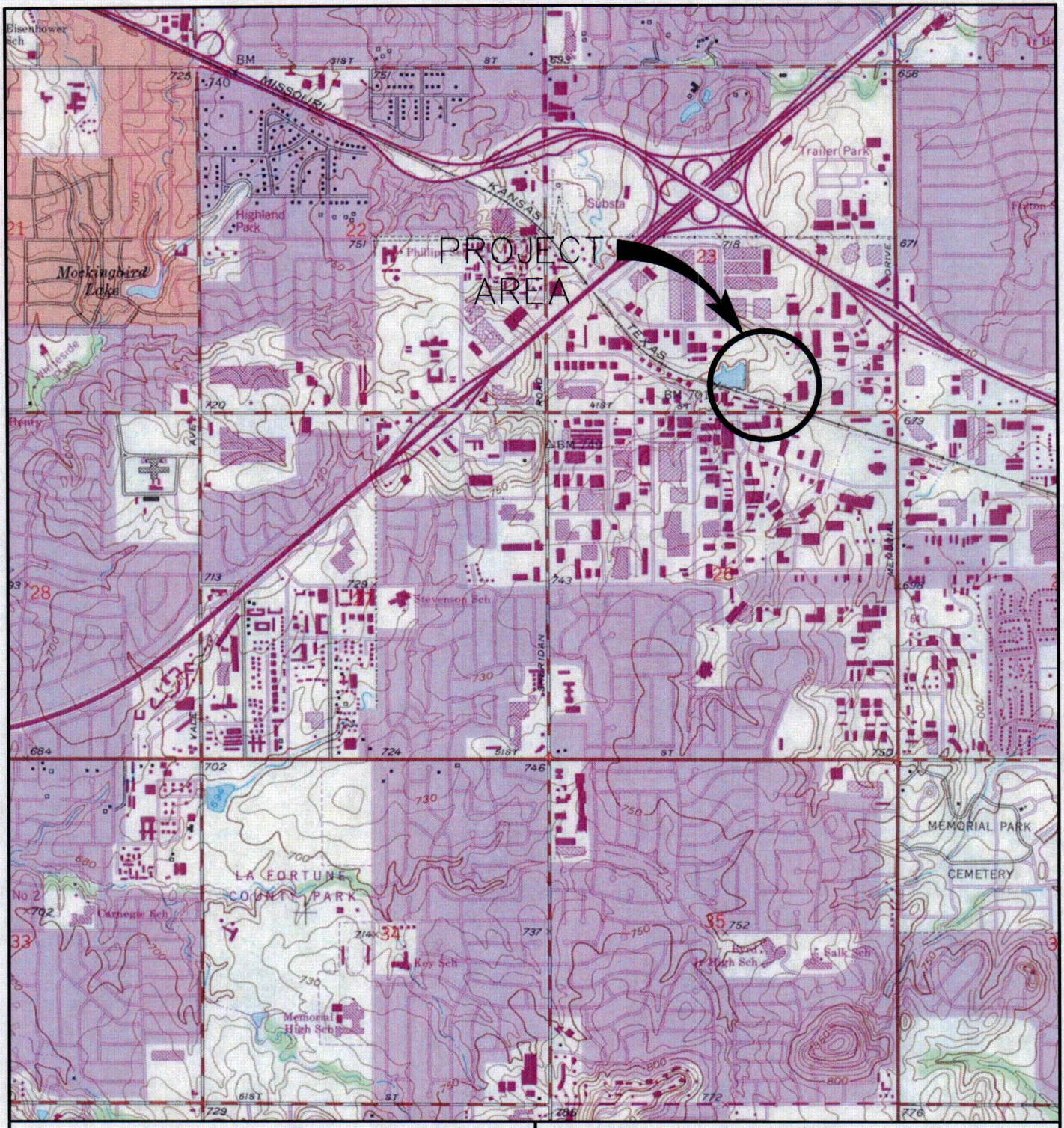
(10) Title 10 CFR Part 20, Subpart E, Radiological Criteria for License Termination.

(11) NUREG-1549, Decision Methods for Dose Assessments to Comply With Radiological Criteria for License Termination.

(12) NUREG/CR-5849, June 1992, Manual for Conducting Radiological Surveys in Support of License Termination.

(13) NRC, 1997, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, NUREG/CR-1507, Final, NRC, Washington, DC.



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SCALE – FEET

0 2000

REFERENCE
USGS 7.5–MIN TOPOGRAPHIC QUADRANGLE
JENKS, OK
DATED 1952, PHOTOREVISED 1982
SCALE 1:24000.

FIGURE 1
SITE LOCATION MAP

THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RFD	06/09/06
CHECKED	RFD	06/09/06
DRAWN	DEB	06/09/06

DRAWING NUMBER
PA4072021

Penn E&R
Environmental & Remediation, Inc.

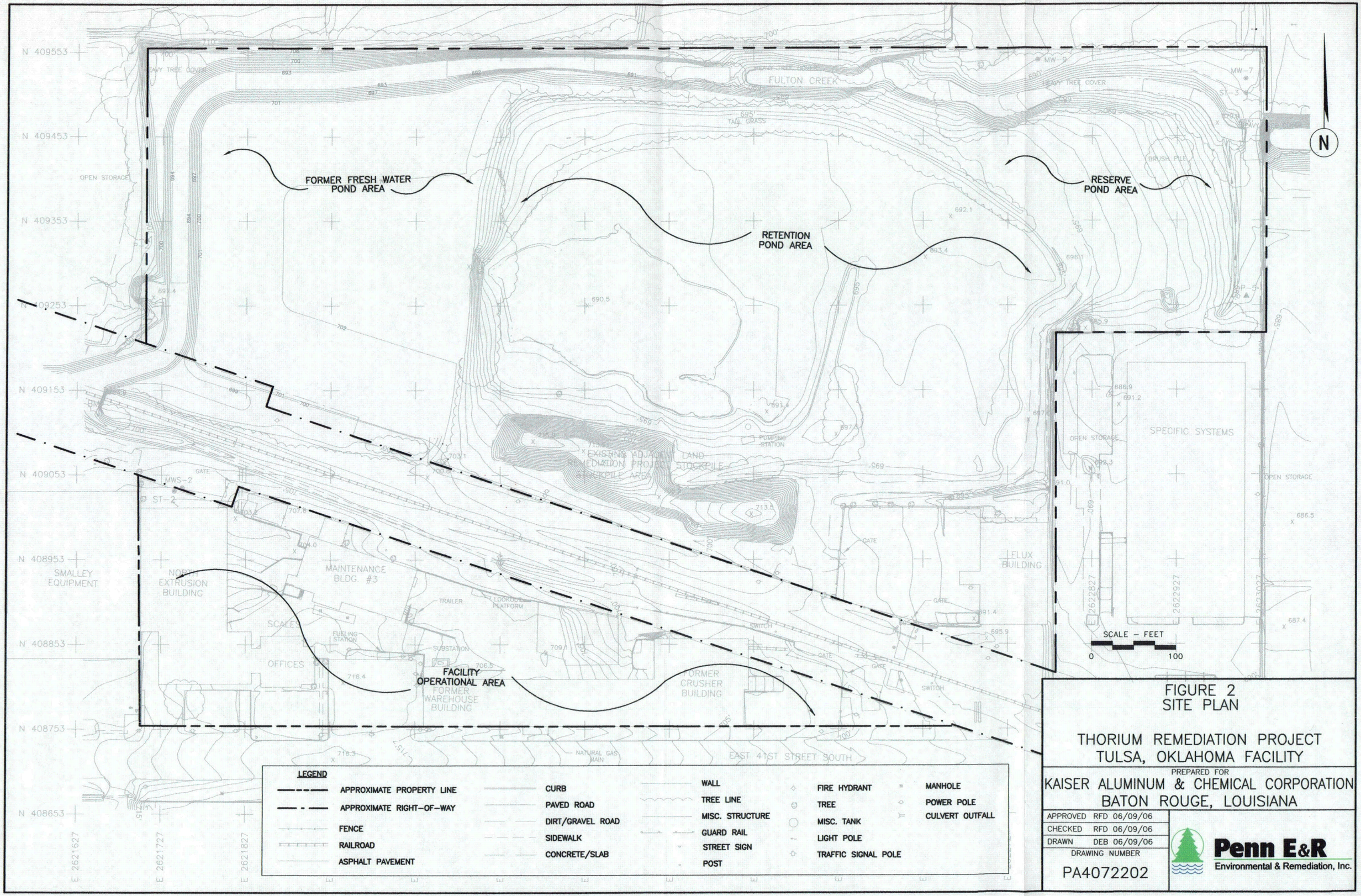

FIGURE 2
SITE PLAN

THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RFD	06/09/06
CHECKED	RFD	06/09/06
DRAWN	DEB	06/09/06

DRAWING NUMBER
PA4072202

Penn E&R
Environmental & Remediation, Inc.

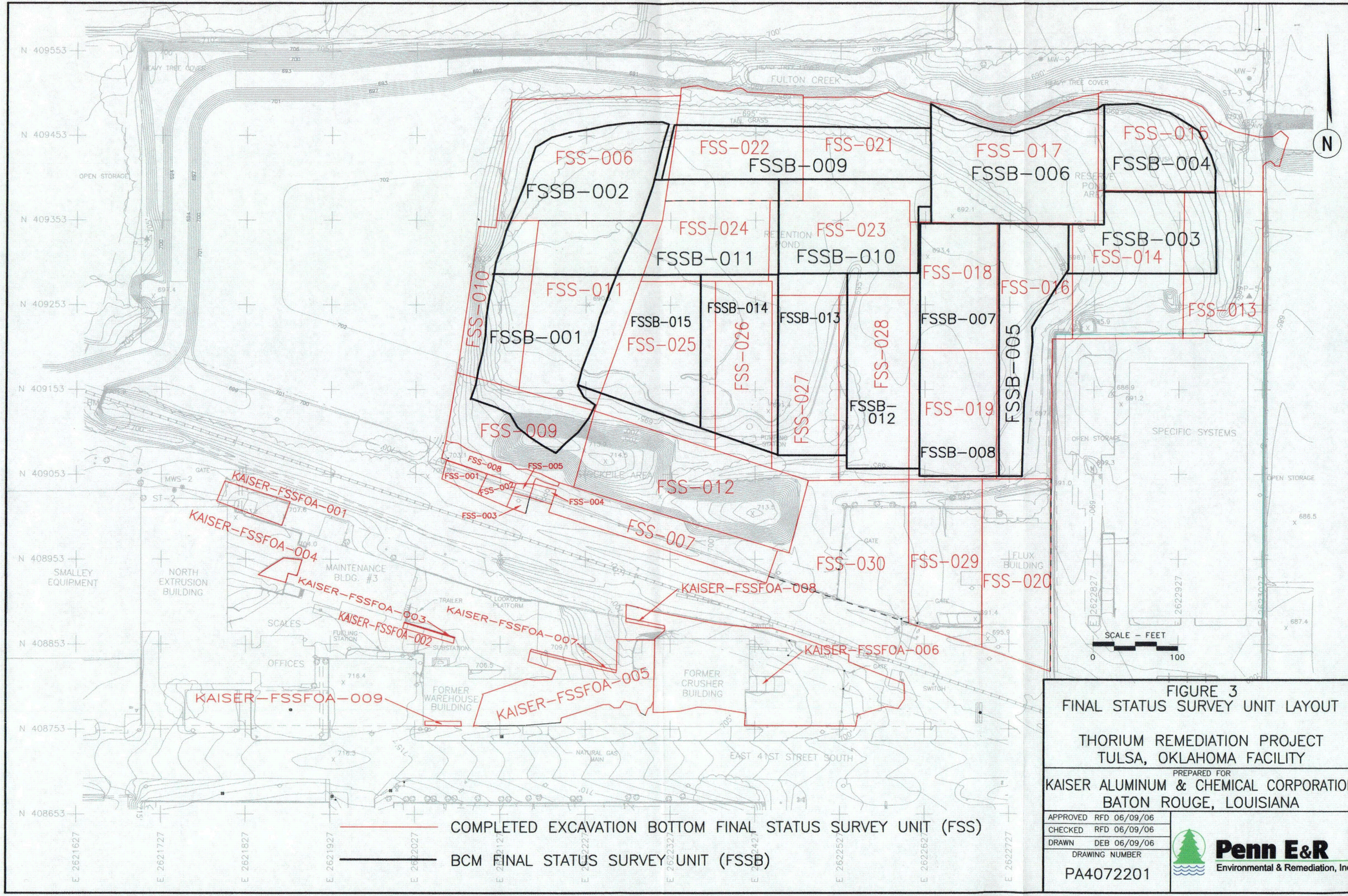

FIGURE 3
FINAL STATUS SURVEY UNIT LAYOUT

THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RFD 06/09/06
CHECKED	RFD 06/09/06
DRAWN	DEB 06/09/06

DRAWING NUMBER
PA4072201

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Environmental & Remediation, Inc.

SUB-REPORT

SURVEY UNIT KAISER-FSSB-010

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Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
July 12, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation backfill unit final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility **(Figure 1)**. Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSSB-010, which consists of a unit of Below Criteria Material or BCM (less than 31.1 net pCi/g Th-232 material) placed in an excavation resulting from the removal of radiologically-affected soil from the Retention Pond area. Survey Unit Kaiser-FSSB-010 is considered a Class 1 survey unit with an approximate base surface area of 1,770 m^2. It is located on the north side of the pond parcel within portions of excavation bottoms associated with Survey Units Kaiser-FSS-018, Kaiser-FSS-021, Kaiser-FSS-022, and Kaiser-FSS-023 **(Figure 3)**. The survey unit is bordered by excavation backfill Survey Unit Kaiser-FSSB-009 to the north, excavation backfill Survey Unit Kaiser-FSSB-011 to the west, excavation backfill Survey Units Kaiser-FSSB-006 and Kaiser-FSSB-007 to the east, and excavation backfill Survey Units Kaiser-FSSB-012 and Kaiser-FSSB-013 to the south.

A total of six 2-foot layers (lifts) of BCM was placed in Survey Unit Kaiser-FSSB-010.

Separate distinct final status surveys were completed for the pond parcel excavation bottom survey units prior to backfilling with BCM. The final status survey of the pond parcel excavation bottom survey units is documented in **Volumes I and IV** of the Final Status Survey Report.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the BCM placed within Survey Unit Kaiser-FSSB-010. The final status survey consisted of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit.

2.1 Gross Gamma Scan

Each 2-foot lift of BCM was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of each lift, the detector was held close to the BCM surface (1 to 2 inches) and moved in a serpentine pattern. Approximate equal-distant background measurements were also obtained at 1-meter above the ground surface for each lift of BCM placed. A statistical summary of the background survey and 100 percent coverage gamma scan of each BCM lift placed in the survey unit is provided below in **Table 1**.

Table 1 – Gross Gamma Scan Results Summary

Name	Date	Lift Area (m^2)	No. of 2-sec. Scans	Scan Rate (m/s)	Ave. (cpm)	Std. Dev. (cpm)	Min. (cpm)	Max. (cpm)	Median (cpm)
1st lift Scan	12/09/05	1,770	1,819	0.49	34,993	1,169	32,831	41,135	34,959
1st lift Bkgrd.	12/09/05	1,770	12	N/A	32,491	843	31,511	33,797	32,148
2nd lift Scan	12/12/05	1,590	1,308	0.61	36,717	3,458	21,611	50,709	36,365
2nd lift Bkgrd.	12/12/05	1,590	15	N/A	34,679	2,194	31,222	38,034	34,583
3rd lift Scan	12/13/05	1,430	1,813	0.39	35,619	3,259	23,142	65,920	35,520
3rd lift Bkgrd.	12/13/05	1,430	12	N/A	33,373	1,201	31,689	36,000	33,370
4th lift Scan	12/15/05	1,300	2,019	0.32	37,178	3,946	24,638	49,446	36,859
4th lift Bkgrd.	12/15/05	1,300	12	N/A	34,800	2,387	31,278	39,385	34,040
5th lift Scan	12/16/05	1,190	1,705	0.35	42,119	7,200	26,047	65,005	39,441
5th lift Bkgrd.	12/16/05	1,190	8	N/A	39,271	5,160	33,557	48,916	37,920
6th lift Scan	12/19/05	1,070	1,739	0.31	39,718	6,061	24,326	73,355	38,478
6th lift Bkgrd.	12/19/05	1,070	12	N/A	38,233	4,188	34,744	49,808	36,789

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented by BCM lift on **Figures A-1 through A-6** contained in **Attachment A.**

The 100 percent coverage gross gamma scan of the 2-foot lifts did not indicate the presence of small areas (1 m^2) of elevated activity (above the DCCL for the site).

2.2 Systematic Soil Core Sampling

The final status survey also consisted of systematic soil core sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Core Samples (core holes) Required (N) based on the scan MDC was determined to be 9, as documented on Soil Survey Unit Worksheet No. 1 (**Attachment B**). Once N was determined, the Survey Unit Area (A) of 1,770 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 15.1 meters and the Height of the Equilateral Triangle (h) of 13.1 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 (**Attachment B**).

A layout of the soil sampling locations is provided on **Figure A-7** contained in **Attachment A**. The soil core sample locations were demarcated in the field using a GPS unit. A total of 9 core holes (sample locations) were installed on the grid prescribed over the survey unit (Cores Nos. 1 through 9). Core segments of BCM (typically 3 feet in length) were scanned in the field in 1-foot increments. The 1-foot increments were also characterized by a 1 minute static count of gross gamma activity. The results are presented below in **Table 2**.

Table 2 - Soil Core Segment Gross Gamma Survey Results

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
1	A	36	1	22	22,253	1,174
1	A		2	21	22,798	1,719
1	A		3	22	22,288	1,209
1	B	48	4	20	20,797	-282
1	B		5	20	20,120	-959
1	B		6	20	21,061	-18
1	B		7	20	20,426	-653
2	A	36	1	23	25,171	4,092
2	A		2	25	23,808	2,729
2	A		3	24	25,539	4,460
2	B	48	4	22	22,187	1,108
2	B		5	22	22,198	1,119
2	B		6	23	22,584	1,505
2	B		7	22	22,087	1,008
3	A	36	1	22	22,902	1,823
3	A		2	22	23,252	2,173
3	A		3	22	23,441	2,362
3	B	36	4	22	21,838	759
3	B		5	21	20,585	-494
3	B		6	22	22,504	1,425
3	C	24	7	20	20,872	-207
3	C		8	21	23,651	2,572
4	A	36	1	23	23,260	2,181

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
4	A		2	23	22,348	1,269
4	A		3	23	23,481	2,402
4	B	36	4	20	22,120	1,041
4	B		5	20	21,968	889
4	B		6	21	21,435	356
4	C	36	7	20	20,951	-128
4	C		8	21	20,959	-120
4	C		9	22	21,408	329
5	A	24	1	23	24,416	3,337
5	A		2	24	23,449	2,370
5	B	36	3	23	24,893	3,814
5	B		4	22	22,996	1,917
5	B		5	23	22,328	1,249
5	C	48	6	22	22,957	1,878
5	C		7	22	21,143	64
5	C		8	20	21,464	385
5	C		9	20	21,611	532
6	A	36	1	22	22,943	1,864
6	A		2	22	23,293	2,214
6	A		3	23	23,152	2,073
6	B	36	4	22	21,779	2,073
6	B		5	21	22,930	1,851
6	B		6	22	23,015	1,936
6	C	36	7	21	22,304	1,225
6	C		8	21	21,615	536
6	C		9	21	22,399	1,320
7	A	36	1	21	22,897	1,818
7	A		2	22	22,614	1,535
7	A		3	22	23,997	2,918
7	B	36	4	21	21,974	895
7	B		5	21	21,260	181
7	B		6	22	22,356	1,277
7	C	36	7	22	23,104	2,025
7	C		8	22	22,870	1,791
7	C		9	23	22,953	1,874
7	D	24	10	21	21,165	86
7	D		11	21	21,698	619
8	A	36	1	21	22,013	934
8	A		2	22	23,250	2,171
8	A		3	23	22,848	1,769
8	B	36	4	22	22,176	1,097
8	B		5	22	22,133	1,054
8	B		6	22	22,775	1,696
8	C	36	7	22	23,211	2,132
8	C		8	22	23,168	2,089
8	C		9	22	23,115	2,036

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
8	D	24	10	22	21,952	873
8	D		11	22	22,438	1,359
9	A	36	1	22	22,489	1,410
9	A		2	22	24,734	3,655
9	A		3	23	22,173	1,094
9	B	36	4	21	22,208	1,129
9	B		5	21	21,440	361
9	B		6	21	22,646	1,567
9	C	36	7	22	22,621	1,542
9	C		8	22	23,098	2,019
9	C		9	22	23,050	1,971
9	D	24	10	21	22,073	994
9	D		11	21	22,232	1,153
			Count:	*82*	*82*	*82*
			Average:	*22*	*22,484*	*1,422*
			Std. Dev.:	*1.0*	*1,039*	*1,039*
			Minimum:	*20*	*20,120*	*-959*
			Maximum:	*25*	*25,539*	*4,460*
			Median:	*22*	*22,419*	*1,385*

[1]Net Static Count values (cpm) are equal to the Gross Static Count minus a background value of 21,079 cpm based on the average of 5 consecutive 1-minute counts performed with the detector on top of the table used to scan the cores, prior to scan activities.

A composite sample representing each core segment was then prepared by combining each set of three 1-foot increments in a bucket and breaking up the cores. The final segment of core may be less than or greater than 3 feet depending on the point at which virgin material was encountered. A sample (usually between 500 and 800 grams) was taken from each composite and forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3**. Analytical data reports are contained in **Attachment C**.

Table 3 – Systematic Soil Core Composite Sample Results

Core Number	Core Segment	Segment Length (in.)	Composite Sample No.	Core Depth (ft)	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)[1]
1	A	36	K-1369	1	7.51	0.459	0.454	6.41
1	B	48	K-1370	4	5.06	0.488	0.611	3.96
2	A	36	K-1371	1	11.0	0.657	0.845	9.90
2	B	48	K-1372	4	5.63	0.370	0.408	4.53
3	A	36	K-1373	1	7.44	0.594	0.717	6.34
3	B	36	K-1374	4	3.46	0.299	0.222	2.36
3	C	24	K-1375	7	5.78	0.362	0.321	4.68
4	A	36	K-1376	1	6.65	0.520	0.442	5.55
4	B	36	K-1377	4	3.67	0.334	0.421	2.57
4	C	36	K-1378	7	4.80	0.432	1.00	3.70
5	A	24	K-1379	1	8.11	0.657	0.632	7.01

Core Number	Core Segment	Segment Length (in.)	Composite Sample No.	Core Depth (ft)	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)[1]
5	B	36	K-1380	3	16.0	0.912	0.581	14.9
5	C	48	K-1381	6	4.68	0.392	0.568	3.58
6	A	36	K-1382	1	6.26	0.370	0.272	5.16
6	B	36	K-1383	4	6.30	0.453	0.808	5.20
6	C	36	K-1384	7	5.97	0.459	0.493	4.87
7	A	36	K-1385	1	6.51	0.328	0.271	5.41
7	B	36	K-1386	4	4.92	0.413	0.687	3.82
7	C	36	K-1387	7	5.43	0.691	0.727	4.33
7	D	24	K-1388	10	4.70	0.368	0.290	3.60
8	A	36	K-1389	1	6.32	0.475	0.884	5.22
8	B	36	K-1390	4	5.34	0.353	0.392	4.24
8	C	36	K-1391	7	5.01	0.393	0.487	3.91
9	D	24	K-1392	10	4.83	0.311	0.219	3.73
9	A	36	K-1393	1	6.90	0.416	0.257	5.80
9	B	36	K-1394	4	4.67	0.497	0.447	3.57
9	C	36	K-1395	7	7.37	0.530	0.255	6.27
9	D	24	K-1396	10	5.67	0.639	0.673	4.57
				Count:	*28*		*Count:*	*28*
				Average:	*6.29*		*Average:*	*5.19*
				Std. Dev.:	*2.43*		*Std. Dev.:*	*2.43*
				Minimum:	*3.46*		*Minimum:*	*2.36*
				Maximum:	*16.0*		*Maximum:*	*14.9*
				Median:	*5.73*		*Median:*	*4.63*

[1]Net Th-232 activity concentration (pCi/g) is equal to the Gross Th-232 activity concentration minus the established background value of 1.1 pCi/g Th-232.

The net Th-232 activity concentrations for all 28 systematic composite samples were below the BCM surrogate value of 31.1 pCi/g net Th-232 activity concentration (DCCL). The maximum net Th-232 activity concentration was 14.9 pCi/g. The average net Th-232 activity concentration was 5.19 pCi/g. The standard deviation of the 28 composite samples was 2.43, which fell below the estimated standard deviation of 4.4 used to calculate the minimum number of samples required in the decommissioning plan.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil core composite samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit core sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (15.53 pCi/g) between the maximum survey unit soil sample gross activity concentration (16.0 pCi/g) and the minimum reference background area soil sample activity concentration (0.47 pCi/g) is less than DCCL (31.1 pCi/g), then the survey unit meets the release

criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Gross Th-232 (pCi/g)
R1	240	1.08	S1	K-1369	7.51
R2	341	1.61	S2	K-1370	5.06
R3	52	1.63	S3	K-1371	11.0
R4	196	0.91	S4	K-1372	5.63
R5	70	0.47	S5	K-1373	7.44
R6	236	1.14	S6	K-1374	3.46
R7	328	1.25	S7	K-1375	5.78
R8	287	1.02	S8	K-1376	6.65
R9	155	1.04	S9	K-1377	3.67
R10	109	1.27	S10	K-1378	4.80
R11	182	1.16	S11	K-1379	8.11
R12	27	1.24	S12	K-1380	16.0
R13	137	1.22	S13	K-1381	4.68
R14	51	1.72	S14	K-1382	6.26
R15	261	1.30	S15	K-1383	6.30
R16	32	1.36	S16	K-1384	5.97
R17	120	1.08	S17	K-1385	6.51
R18	211	1.62	S18	K-1386	4.92
R19	29	0.90	S19	K-1387	5.43
R20	57	0.96	S20	K-1388	4.70
R21	274	1.37	S21	K-1389	6.32
R22	231	1.38	S22	K-1390	5.34
R23	352	1.09	S23	K-1391	5.01
R24	1	0.98	S24	K-1392	4.83
R25	8	1.24	S25	K-1393	6.90
R26	151	1.52	S26	K-1394	4.67
R27	273	0.84	S27	K-1395	7.37
R28	128	1.07	S28	K-1396	5.67
	Average:	***1.20***		***Average:***	***6.29***
	Std. Dev.	***0.28***		***Std. Dev.***	***2.43***
	Minimum:	***0.47***		***Minimum:***	***3.46***
	Maximum:	***1.72***		***Maximum:***	***16.0***
	Median:	***1.19***		***Median:***	***5.73***

3.0 SUMMARY OF FINDINGS

Survey Unit Kaiser-FSSB-010, which consists of a unit of BCM placed in an excavation resulting from the removal of radiologically-affected soil from the Retention Pond area, is considered a Class 1 survey unit with an approximate base surface area of 1,770 m^2. It is located on the north side of the pond parcel within portions of excavation bottoms associated with Survey Units Kaiser-FSS-018, Kaiser-FSS-021, Kaiser-FSS-022, and Kaiser-FSS-023 (**Figure 3**). The survey unit is bordered by excavation backfill Survey Unit Kaiser-FSSB-009 to the north, excavation backfill Survey Unit Kaiser-FSSB-011 to the west, excavation backfill Survey Units Kaiser-FSSB-006 and Kaiser-FSSB-007 to the east, and excavation backfill Survey Units Kaiser-FSSB-012 and Kaiser-FSSB-013 to the south.

A total of six 2-foot layers (lifts) of BCM was placed in Survey Unit Kaiser-FSSB-010.

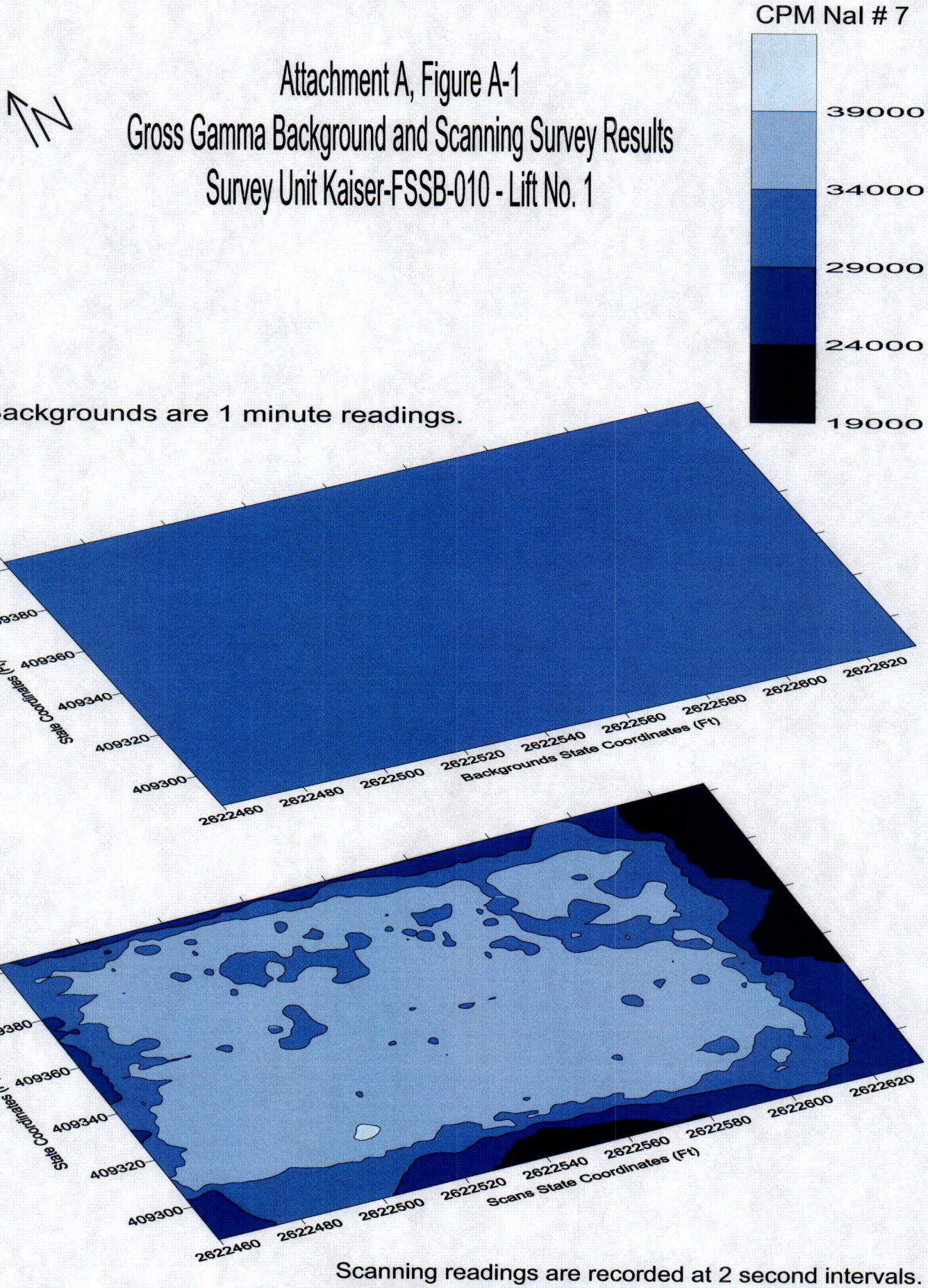
The acceptance criterion for BCM survey units at the Tulsa facility is the DCCL of 31.1 pCi/g net Th-232 activity concentration. The final status survey consisted of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan of each lift (final as-left condition) did not indicate the presence of small areas (1 m^2) of elevated activity (greater than the DCCL for the site).
- The net Th-232 activity concentrations for all 28 systematic composite core samples were below the BCM surrogate value of 31.1 pCi/g net Th-232 activity concentration (DCCL).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).

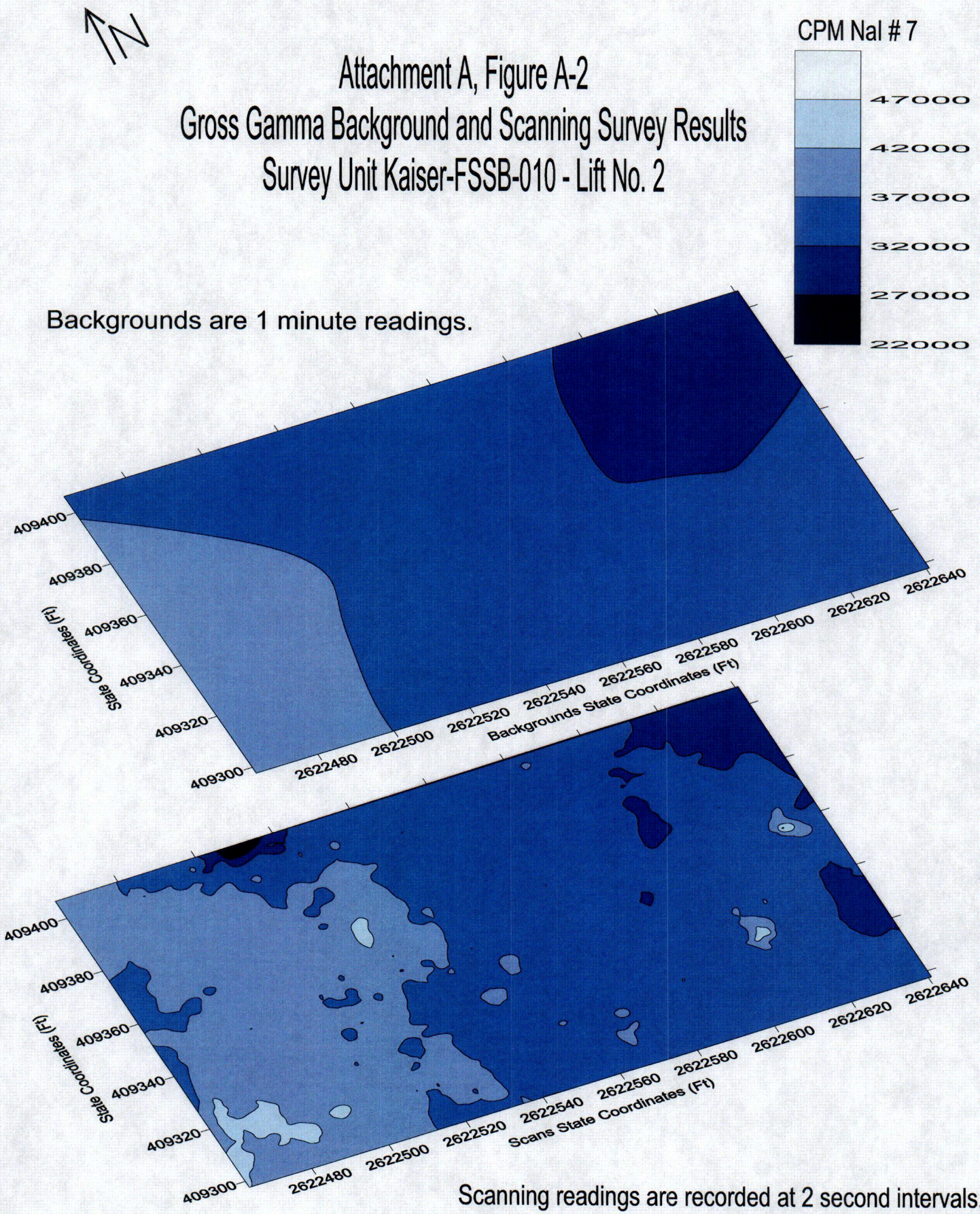
The results of the final status survey activities show that Survey Unit Kaiser-FSSB-010 meets the DP acceptance criteria.

ATTACHMENT A
TABLE OF CONTENTS

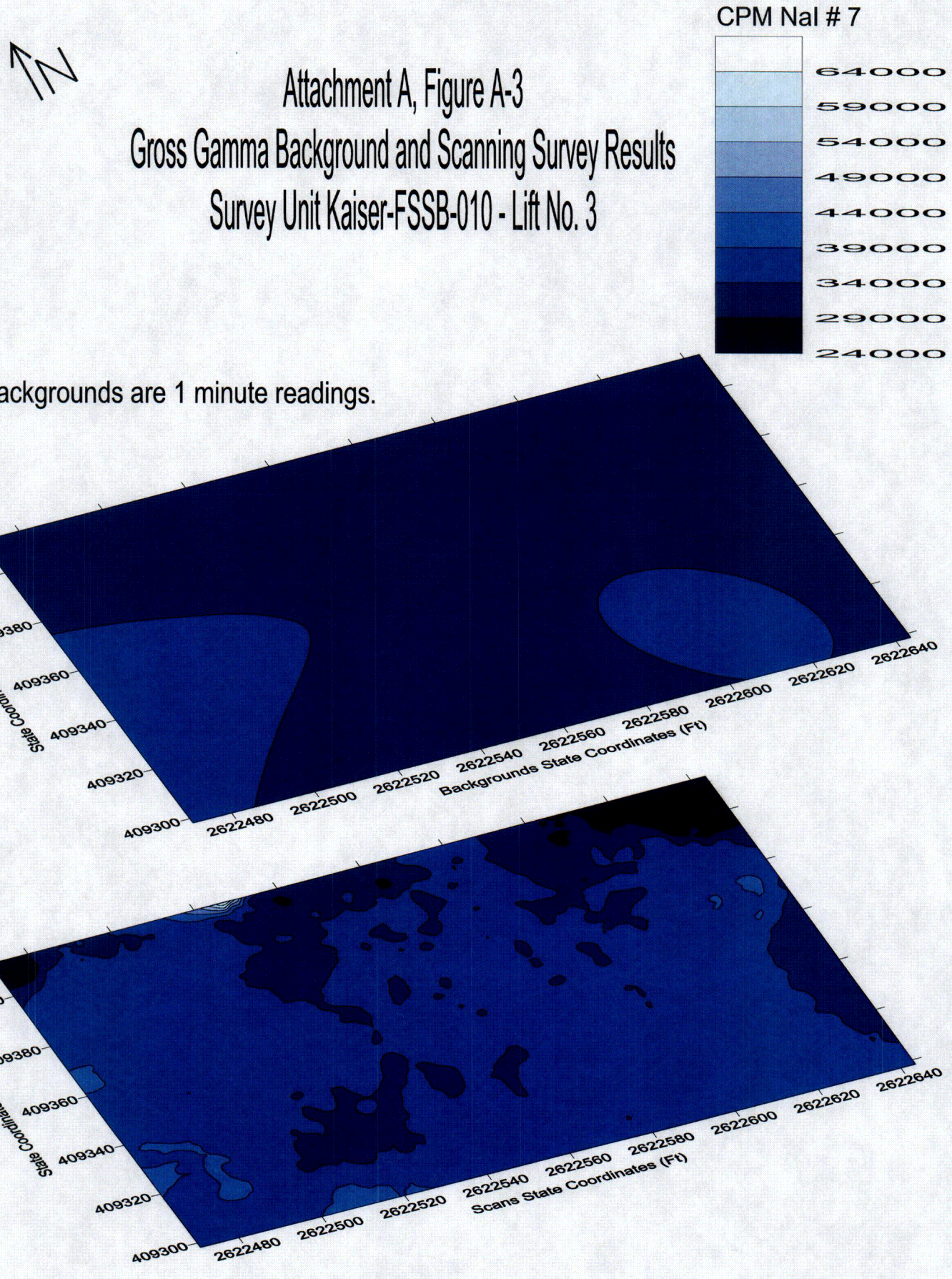
Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-010 - Lift No. 1



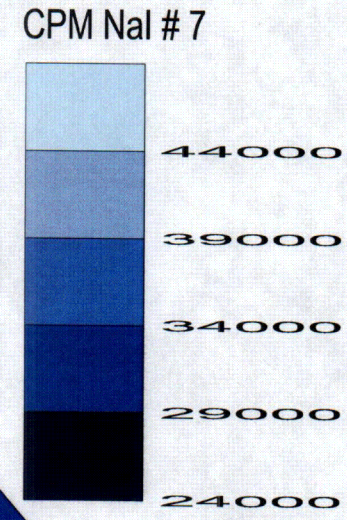
Attachment A, Figure A-2
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-010 - Lift No. 2



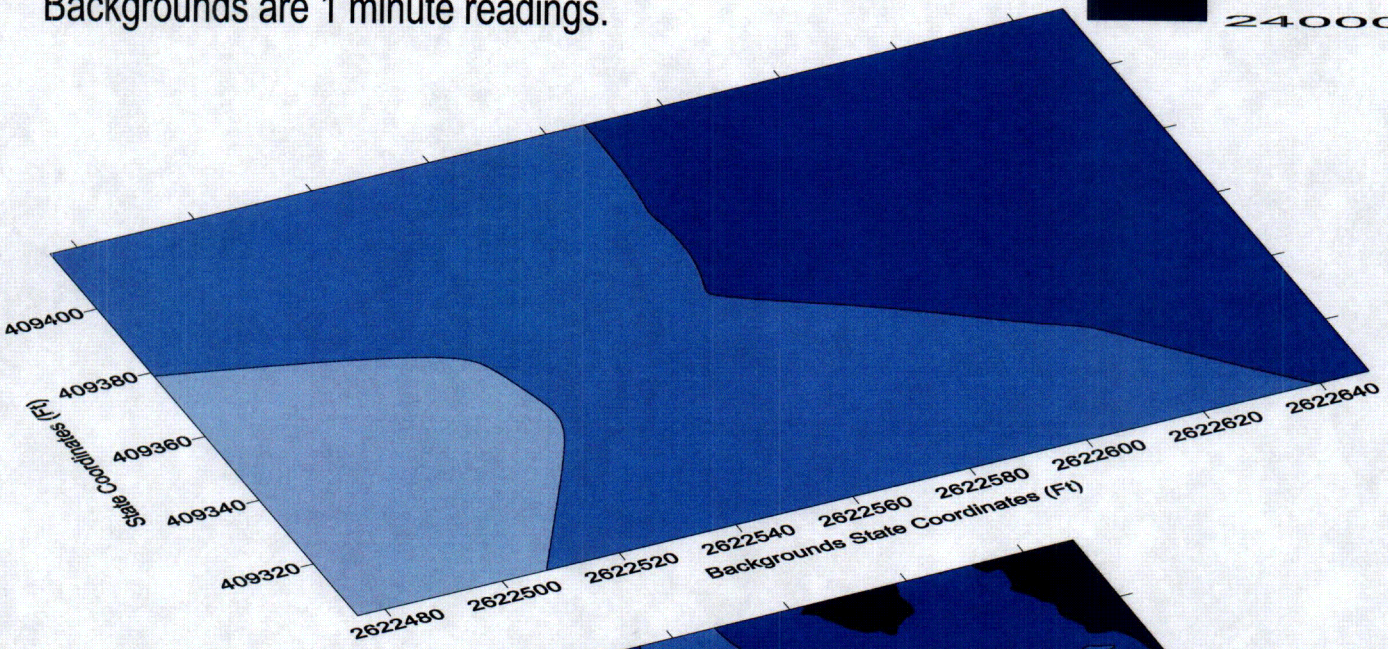
Attachment A, Figure A-3
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-010 - Lift No. 3

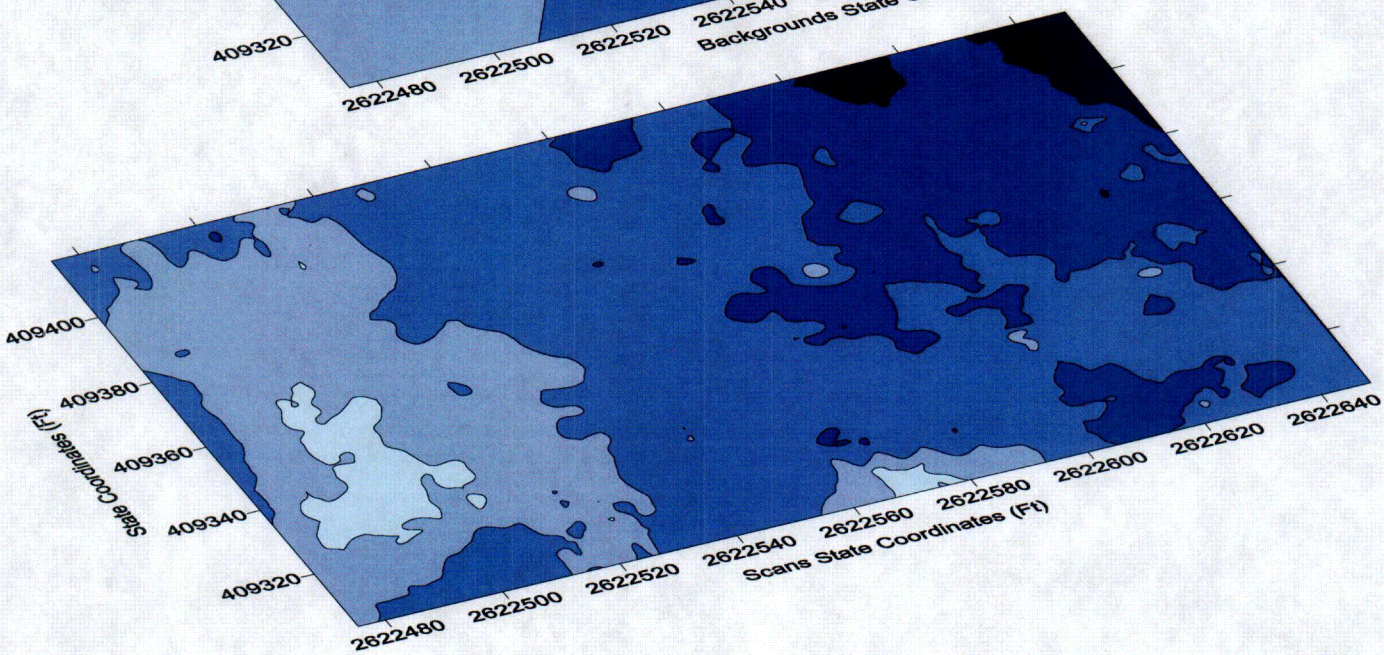


Attachment A, Figure A-4
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-010 - Lift No. 4



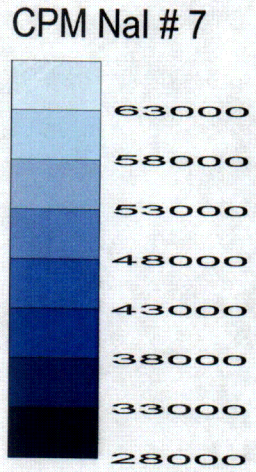
Backgrounds are 1 minute readings.



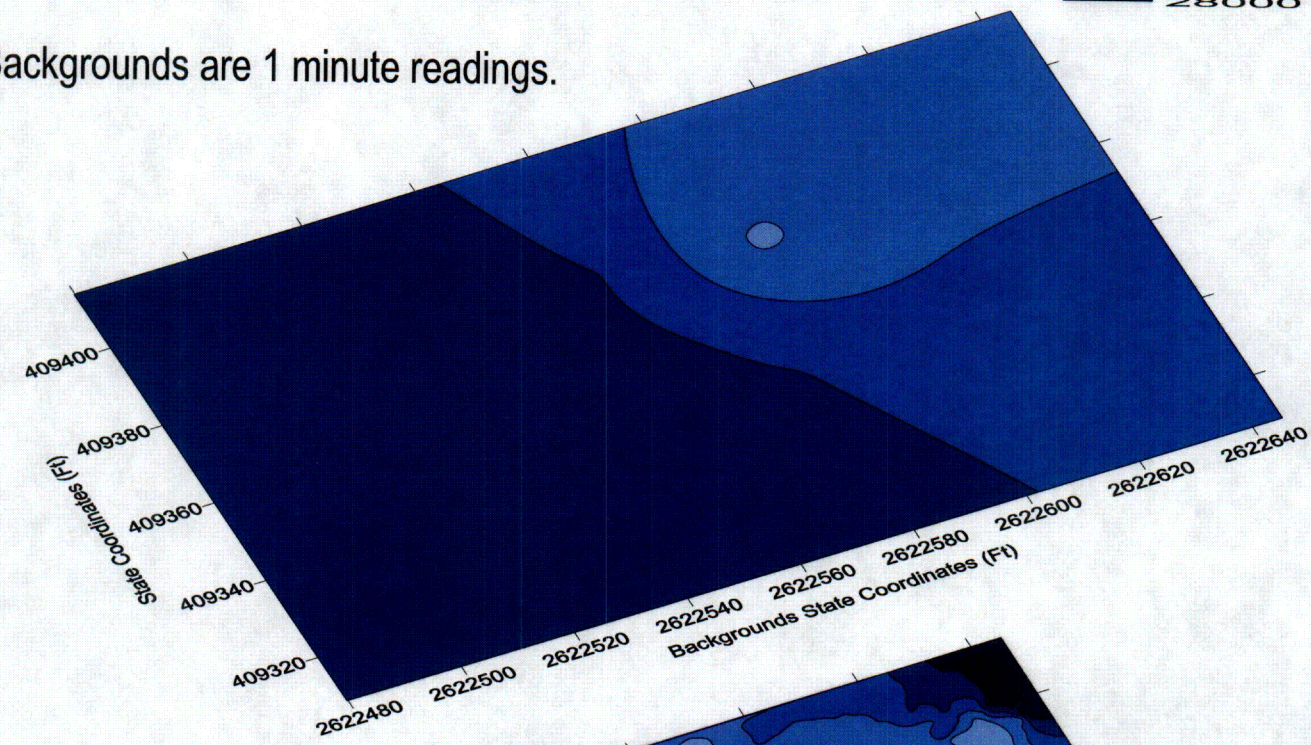


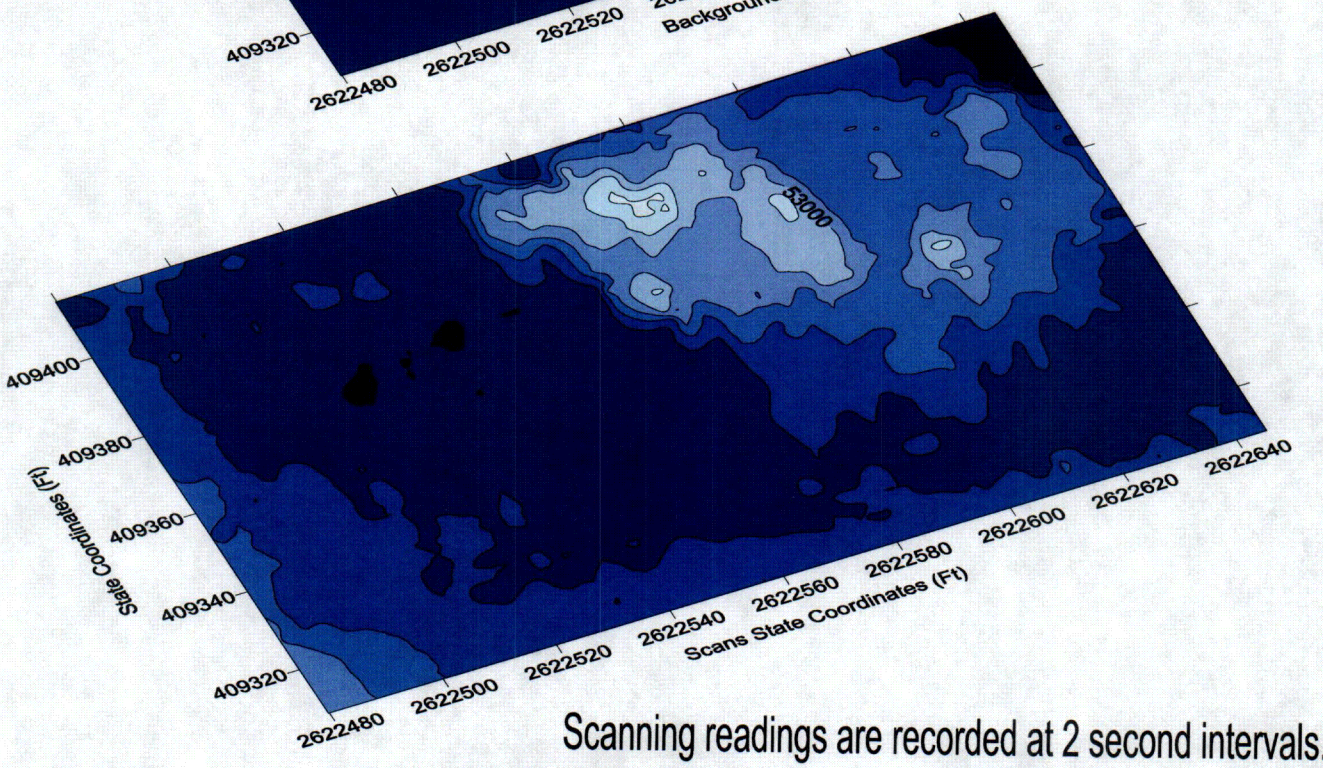
Scanning readings are recorded at 2 second intervals.

Attachment A, Figure A-5
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-010-Lift No. 5



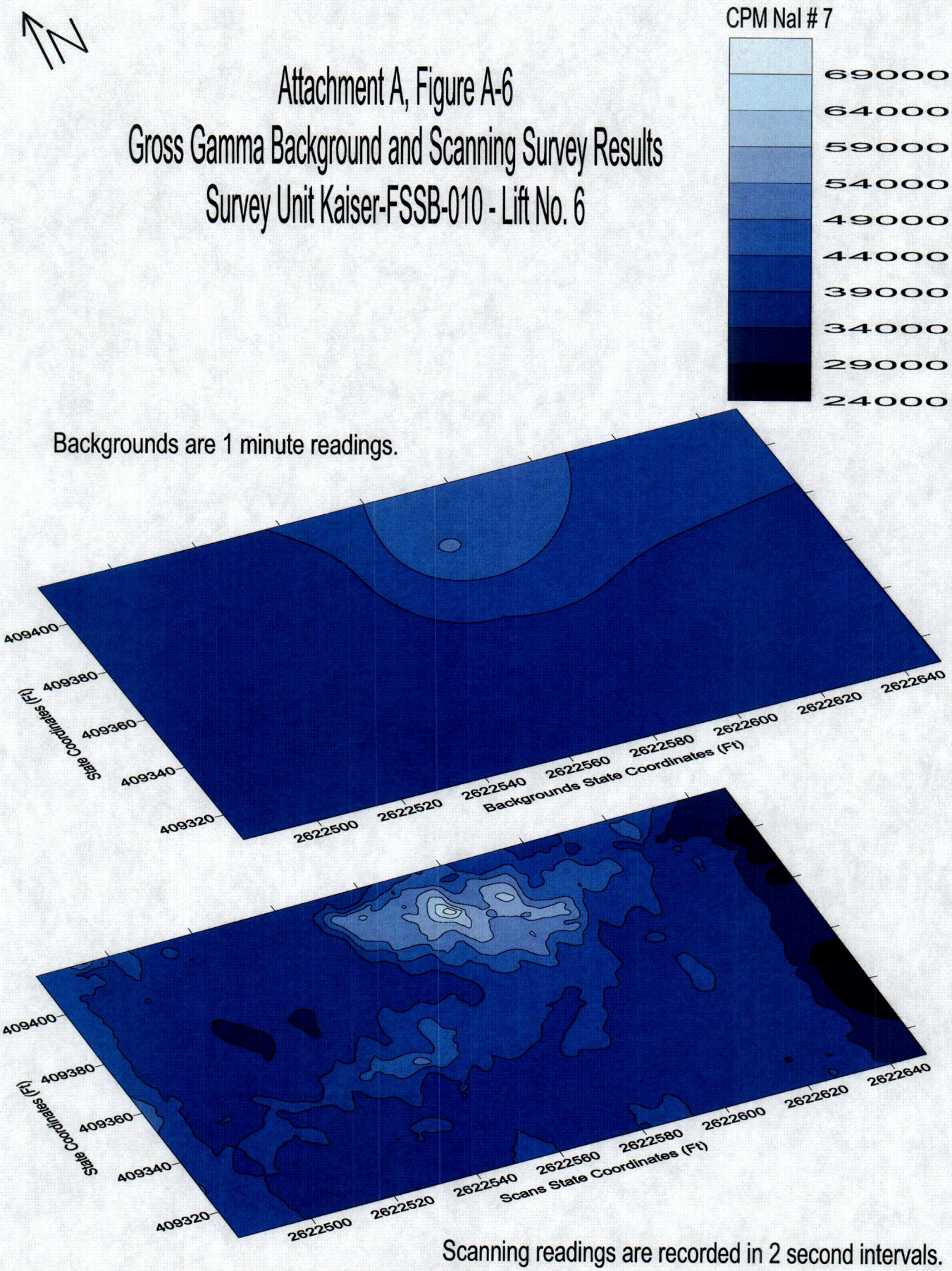
Backgrounds are 1 minute readings.

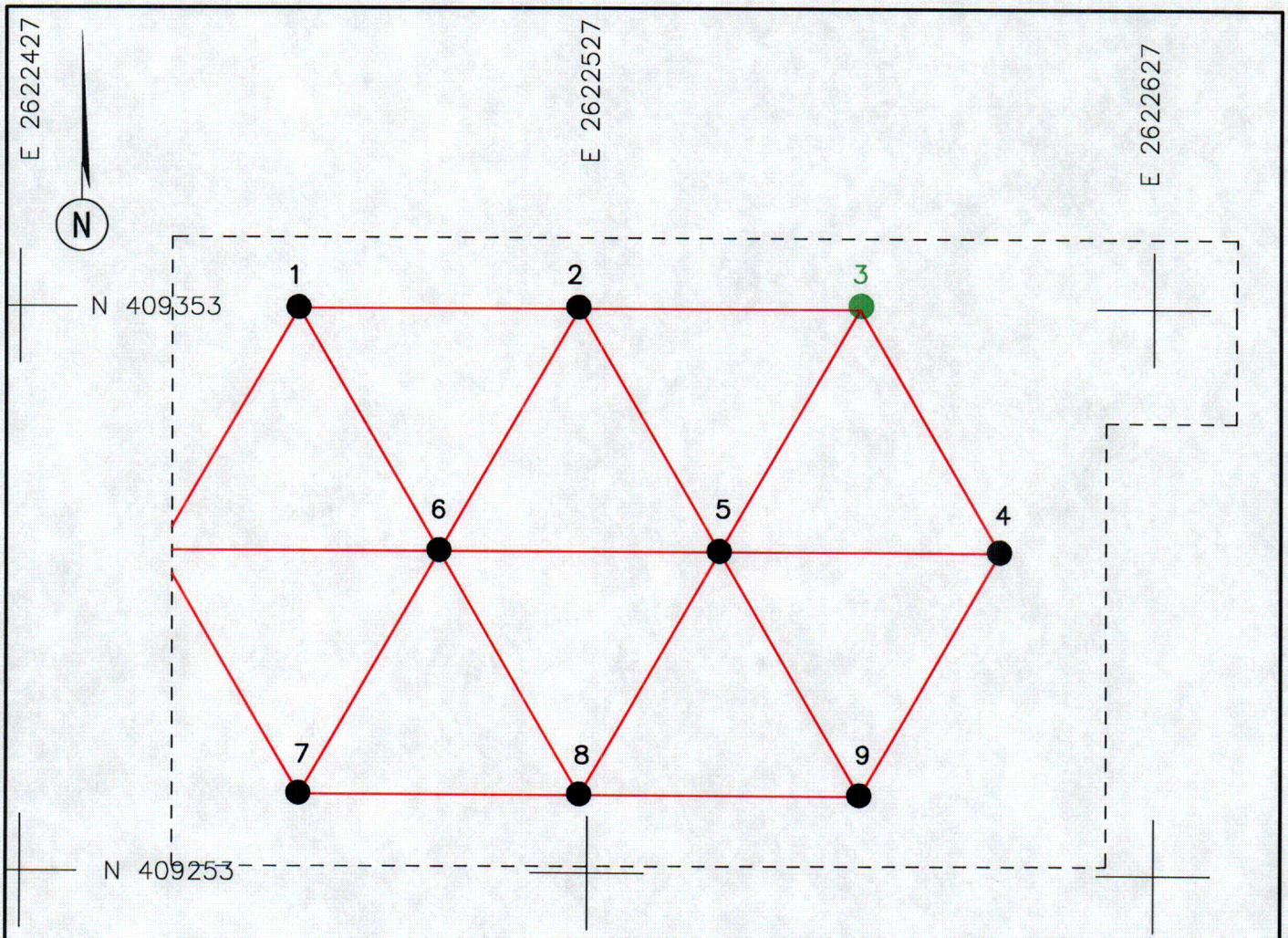


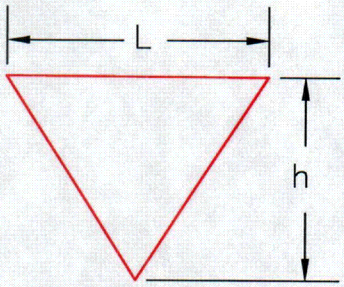


Scanning readings are recorded at 2 second intervals.

Attachment A, Figure A-6
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-010 - Lift No. 6







N = 9
L = 15.1m
h = 13.1m
AREA = 1,770m^2

SCALE – FEET
30 0 30
9 0 9
SCALE – METERS

1 ● SYSTEMATIC SOIL CORE SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

3 ● RANDOM START POINT

FIGURE A–7
SYSTEMATIC SOIL CORE SAMPLING LOCATIONS SURVEY UNIT KAISER – FSSB–010 FINAL STATUS SURVEY THORIUM REMEDIATION PROJECT TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RFD 7/12/06
CHECKED	RFD 7/12/06
DRAWN	DEB 12/15/05
DRAWING NUMBER	PA4072049A

Penn E&R
Environmental & Remediation, Inc.

H:\4000–PA\2\PA4072049A.dwg, 7/11/2006 9:08:46 AM

ATTACHMENT B
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Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: Kaiser-FSSB-010

2. Description: Pond Parcel Excavation Backfill Unit

3. Net Th-232 Acceptance Criteria (pCi/g): 31.1

4. Dimensions (m): Approximately 52 meters x 34 meters; Area, A (m^2): 1,770

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 75,000 Minimum: 50,000 Maximum: 100,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 5.7
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 15.1

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 13.1 m.

1

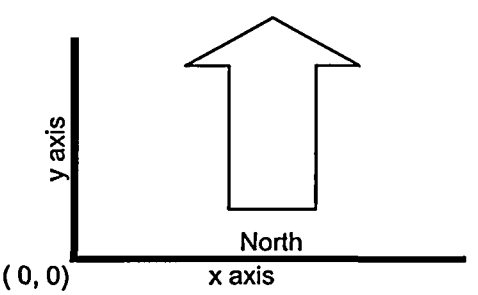
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSSB-010

RANDOM START POINT

x axis (Meters)	y axis (Meters)
37	30

	x axis	y axis
lower bound	0	0
upper bound	52	34



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach
Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Limit # 11705
D/. 1/30/06

January 25, 2006

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20051034

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on December 22, 2005 for the above captioned project. Thirty-two soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with a standard 20-work day turn.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach
Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20051034
Date Reported:	1/25/06
Date Received:	12/22/05
Page Number:	1 of 8

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20051034-01**						
Client ID:	**K-1369**						
Date Sampled:	**12/21/05 9:12:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	7.51 +/- 0.459	pCi/g	0.454		1/11/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.5	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-02**						
Client ID:	**K-1370**						
Date Sampled:	**12/21/05 9:25:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.06 +/- 0.488	pCi/g	0.611		1/11/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.8	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-03**						
Client ID:	**K-1371**						
Date Sampled:	**12/21/05 9:35:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	11.0 +/- 0.657	pCi/g	0.845		1/11/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.4	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-04**						
Client ID:	**K-1372**						
Date Sampled:	**12/21/05 9:45:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.63 +/- 0.370	pCi/g	0.408		1/11/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.3	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-05**						
Client ID:	**K-1373**						
Date Sampled:	**12/21/05 9:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20051034
Date Reported:	1/25/06
Date Received:	12/22/05
Page Number:	2 of 8

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	7.44 +/- 0.594	pCi/g	0.717		1/11/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.8	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-06**						
Client ID:	**K-1374**						
Date Sampled:	**12/21/05 9:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	3.46 +/- 0.299	pCi/g	0.222		1/11/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.1	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-07**						
Client ID:	**K-1375**						
Date Sampled:	**12/21/05 10:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.78 +/- 0.362	pCi/g	0.321		1/12/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	11.2	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-08**						
Client ID:	**K-1376**						
Date Sampled:	**12/21/05 10:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	6.65 +/- 0.520	pCi/g	0.442		1/12/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.8	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-09**						
Client ID:	**K-1377**						
Date Sampled:	**12/21/05 10:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	3.67 +/- 0.334	pCi/g	0.421		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.6	%		1/11/06	1/12/06	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20051034
Date Reported:	1/25/06
Date Received:	12/22/05
Page Number:	3 of 8

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20051034-10**						
Client ID:	**K-1378**						
Date Sampled:	**12/21/05 10:15:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	4.80 +/- 0.432	pCi/g	1.00		1/13/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.5	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-11**						
Client ID:	**K-1379**						
Date Sampled:	**12/21/05 10:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	8.11 +/- 0.657	pCi/g	0.632		1/13/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.4	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-12**						
Client ID:	**K-1380**						
Date Sampled:	**12/21/05 10:25:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	16.0 +/- 0.912	pCi/g	0.581		1/13/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.2	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-13**						
Client ID:	**K-1381**						
Date Sampled:	**12/21/05 10:31:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	4.68 +/- 0.392	pCi/g	0.568		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.7	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-14**						
Client ID:	**K-1382**						
Date Sampled:	**12/21/05 10:45:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20051034
Date Reported:	1/25/06
Date Received:	12/22/05
Page Number:	4 of 8

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	6.26 +/- 0.370	pCi/g	0.272		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.8	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-15**						
Client ID:	**K-1383**						
Date Sampled:	**12/21/05 10:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	6.30 +/- 0.453	pCi/g	0.808		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.5	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-16**						
Client ID:	**K-1384**						
Date Sampled:	**12/21/05 10:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.97 +/- 0.459	pCi/g	0.493		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.4	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-17**						
Client ID:	**K-1385**						
Date Sampled:	**12/21/05 11:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	6.51 +/- 0.328	pCi/g	0.271		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.6	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-18**						
Client ID:	**K-1386**						
Date Sampled:	**12/21/05 11:03:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	4.92 +/- 0.413	pCi/g	0.687		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.9	%		1/11/06	1/12/06	RT

BDL = Below Detection Limit

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20051034
Date Reported:	1/25/06
Date Received:	12/22/05
Page Number:	5 of 8

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20051034-19**						
Client ID:	**K-1387**						
Date Sampled:	**12/21/05 11:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.43 +/- 0.691	pCi/g	0.727		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.4	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-20**						
Client ID:	**K-1388**						
Date Sampled:	**12/21/05 11:15:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	4.70 +/- 0.368	pCi/g	0.290		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.9	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-21**						
Client ID:	**K-1389**						
Date Sampled:	**12/21/05 11:18:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	6.32 +/- 0.475	pCi/g	0.884		1/16/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.4	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-22**						
Client ID:	**K-1390**						
Date Sampled:	**12/21/05 11:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.34 +/- 0.353	pCi/g	0.392		1/17/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.6	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-23**						
Client ID:	**K-1391**						
Date Sampled:	**12/21/05 11:25:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20051034
Date Reported:	1/25/06
Date Received:	12/22/05
Page Number:	6 of 8

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	5.01 +/- 0.393	pCi/g	0.487		1/17/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.9	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-24**						
Client ID:	**K-1392**						
Date Sampled:	**12/21/05 11:35:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	4.83 +/- 0.311	pCi/g	0..219		1/17/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.7	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-25**						
Client ID:	**K-1393**						
Date Sampled:	**12/21/05 11:37:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	6.90 +/- 0.416	pCi/g	0.257		1/17/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.6	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-26**						
Client ID:	**K-1394**						
Date Sampled:	**12/21/05 11:44:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	4.67 +/- 0.497	pCi/g	0.447		1/17/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.2	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-27**						
Client ID:	**K-1395**						
Date Sampled:	**12/21/05 11:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	7.37 +/- 0.530	pCi/g	0.255		1/17/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.0	%		1/11/06	1/12/06	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20051034
Date Reported:	1/25/06
Date Received:	12/22/05
Page Number:	7 of 8

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20051034-28**						
Client ID:	**K-1396**						
Date Sampled:	**12/21/05 11:55:00 AM**						
Matrix:	**Soil**						
	Radiochemical Analyses						
Thorium 232	HASL 300	5.67 +/- 0.639	pCi/g	0.673		1/17/06	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	13.8	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-29**						
Client ID:	**K-1413**						
Date Sampled:	**12/21/05 11:00:00 AM**						
Matrix:	**Soil**						
	Radiochemical Analyses						
Thorium 232	HASL 300	17.0 +/- 0.876	pCi/g	0.789		1/17/06	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	19.5	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-30**						
Client ID:	**K-1414**						
Date Sampled:	**12/21/05 2:00:00 PM**						
Matrix:	**Soil**						
	Radiochemical Analyses						
Thorium 232	HASL 300	0.897 +/- 0.155	pCi/g	0.206		1/17/06	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	16.1	%		1/11/06	1/12/06	RT
Lab ID:	**20051034-31**						
Client ID:	**K-1415**						
Date Sampled:	**12/21/05 2:05:00 PM**						
Matrix:	**Soil**						
	Radiochemical Analyses						
Thorium 232	HASL 300	79.0 +/- 3.33	pCi/g	1.54		1/18/06	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	47.4	%		1/11/06	1/12/06	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20051034
Date Reported:	1/25/06
Date Received:	12/22/05
Page Number:	8 of 8

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				1/10/06
Ac-228					7.0				1/17/06
Ac-228					NC				1/12/06
Am-241		87.0	88.0	0.9					1/17/06
Am-241		82.0	81.0	1.0					1/10/06
Am-241		83.0	89.0	6.8					1/12/06
Co-60		94.0	91.0	2.9					1/17/06
Co-60		95.0	94.0	1.3					1/10/06
Co-60		94.0	93.0	1.0					1/12/06
Cs-137		95.0	93.0	2.3					1/17/06
Cs-137		94.0	94.0	0.7					1/10/06
Cs-137		95.0	94.0	1.3					1/12/06
rcent Moisture					7.0				1/12/06
.cent Moisture					7.6				1/12/06

Lab Approval: 

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL: 918-384-0566 Cell: 724-799-0071
Company: Kaiser-Alum & Chem Corp.
Name: David B. Weddle
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3330 Fax #: 918-384-3171

Bill To:
Company: Kaiser Perf Eng
Name: David B. Weddle / Paul Hamm
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser-Alum & Chem.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 2a Day Thorium
SAMPLER: David B. Weddle / Project Manager
Signature: David B. Weddle / DBW 12/21/05

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (Th-232)	Th-232 to Client Known Activity	MDC <0.5 pCi/g, 2216.92 Activity Correct					REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1369	12-21-05	0912	Soil	1	500ml Plastic	None	X	X	X	X				Grab
	K-1370		0925		1			X	X	X	X				
	K-1371		0938		1			X	X	X	X				
	K-1372		0945		1			X	X	X	X				
	K-1373		0950		1			X	X	X	X				
	K-1374		0955		1			X	X	X	X				
	K-1375		10:00		1			X	X	X	X				
	K-1376		1005		1			X	X	X	X				
	K-1377		1010		1			X	X	X	X				
	K-1378		1015		1			X	X	X	X				
	K-1379		1020		1			X	X	X	X				
	K-1380		1025		1			X	X	X	X				
	K-1381		1031		1			X	X	X	X				
	K-1382		1045		1			X	X	X	X				

N
A

RELINQUISHED BY: David Weddle / David B. Weddle DATE 12/21/05 TIME 1032 RECEIVED BY: Donna Eidson DATE 12/22/05 TIME 1030

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY:
Sample Condition Upon Receipt: Good
Custody Seals Intact: (Y) N
Cooler Temperature: 4°C

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: LOCAL: 918-384-0566 CELL: 724-799-0071
Company: Kaissa-Alom & Chem Inc.
Name: DAVID B. WEYANT
Address: 7311 E. 41st ST.
City: TULSA State: OK Zip: 74145
Phone: 724-934-3530 Fax #: 918-384-3171

Bill To:
Company: KAISSA/BAR ENG, INC.
Name: DAVID B. WEYANT / PAUL HANDA
Address: 7311 E. 41st ST.
City: TULSA State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: KAISER 4072
PROJECT #: PA-4000-4072
PROJECT NAME: KAISER thorium REMED
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 20 DAY PROJ.
SAMPLER Signature: DAVID B. WEYANT / DAVID BOFFEY

CONTAINER SIZE: 500ml — PLASTIC OR GLASS

PRESERVATIVE #: 1. HNO_3 pH<2 2. Ice <4°C 3. HCl pH<2 4. H_2SO_4 pH<2 5. NaOH pH>11

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE	PRESERVATIVE	Gamma Spec (Th-232)	Return to Client for Analysis	MDC 1.0 pCi/g	ASTM D2216 Moist Content					REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1383	12-21-05	1050	SOIL	1	PLASTIC	NONE	X	X	X	X					GRAB
	K-1384		1055		1			X	X	X	X					
	K-1385		1100		1			X	X	X	X					
	K-1386		1103		1			X	X	X	X					
	K-1387		1105		1			X	X	X	X					
	K-1388		1115		1			X	X	X	X					
	K-1389		1118		1			X	X	X	X					
	K-1390		1120		1			X	X	X	X					
	K-1391		1125		1			X	X	X	X					
	K-1392		1135		1			X	X	X	X					
	K-1393		1137		1			X	X	X	X					
	K-1394		1144		1			X	X	X	X					
	K-1395		1150		1			X	X	X	X					
	K-1396		1155		1			X	X	X	X					

N/A

RELINQUISHED BY: DAVID B. WEYANT DATE 12/22/05 TIME 1030 RECEIVED BY: Donna Edson DATE 12/22/05 TIME 1030

RELINQUISHED BY: ______ DATE ______ TIME ______ RECEIVED BY: ______ DATE ______ TIME ______

FOR LABORATORY USE ONLY:
Sample Condition Upon Receipt: Good
Custody Seals Intact:
Cooler Temperature:

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Local: 918-384-0566 Cell: 724-799-0071

Company: Kaiser - Alum & Chem Inc.
Name: David G. Weyand
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3530 Fax #: 918-384-3171

Bill To:

Company: Kaiser / Env. Eqr
Name: David G. Weyand / Paul Haida
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser - 4072
PROJECT #: PA - 4000 - 4072
PROJECT NAME: Kaiser - Thorium Release
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 20 DAY Project
SAMPLER Signature: David G. Weyand

PRESERVATIVE #: 1. HNO_3 pH<2 2. Ice <4°C 3. HCl pH<2 4. H_2SO_4 pH<2 5. NaOH pH>11

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE (PLASTIC OR GLASS)	PRESERVATIVE #	Gamma Spec (K-232)	Return to Client for Archive	MDC 0.5 pCi/gm	ASTM D2216-92 Moist. Content					REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1413	12-21-05	11:00	Soil	1	500ml Plastic	None	X	X	X	X					Grab
	K-1414	|	1400	|	1	|	|	X	X	X	X					Comp
	K-1415	|	1405	|	1	|	|	X	X	X	X					|

N/A

RELINQUISHED BY: David G. Weyand DATE 12/22/05 TIME 1030 RECEIVED BY: Donna Gidson DATE 12/22/05 TIME 1030

RELINQUISHED BY: ______ DATE ______ TIME ______ RECEIVED BY: ______ DATE ______ TIME ______

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: [illegible]
Sample Condition Upon Receipt: [illegible]
Custody Seals Intact: [illegible]
Cooler Temperature: [illegible]

SAMPLE LOG

Date Received: *12/22/05 1:02:44* Lab Number: 20051034 Due: 1/24/06

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20051034-01 A	K-1369	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20051034-02 A	K-1370	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20051034-03 A	K-1371	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20051034-04 A	K-1372	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-05 A	K-1373	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-06 A	K-1374	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-07 A	K-1375	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-08 A	K-1376	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20051034-09 A	K-1377	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-10 A	K-1378	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes

Th-232 by G[illegible] Spec								
20051034-11 A	K-1379	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-12 A	K-1380	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-13 A	K-1381	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-14 A	K-1382	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-15 A	K-1383	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20051034-16 A	K-1384	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20051034-17 A	K-1385	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20051034-18 A	K-1386	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-19 A	K-1387	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20051034-20 A	K-1388	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								

Percent M[illegible] (LOD) Th-232 by Gamma Spec		[illegible]	12/21/05	[illegible]c	16 oz	None	Yes	Yes
20051034-22 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1390	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
20051034-23 A Gamma Spec - Thorium 232 Percent Moisture (LOD)	K-1391	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
20051034-24 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1392	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
20051034-25 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1393	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
20051034-26 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1394	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
20051034-27 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1395	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
20051034-28 A Gamma Spec - Thorium 232 Percent Moisture (LOD)	K-1396	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
20051034-29 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1413	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
20051034-30 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1414	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes
20051034-31 A	K-1415	Soil	12/21/05	Plastic	16 oz	None	Yes	Yes

Percent M re (LOD)

CONTAINER INSPECTION

Coolers 2 Custody Seals Broken ☐ Temperature Ice Radiation Survey: <300 cpm

SAMPLE INSPECTION

Sample Seal Broken NA Chain of Custody Record ☑ Labels in Tact ☑ Radiation Survey Complete ☑

Anomalies

Inspected By: Michelle D DATE 12/22/05

QA or Designee Review: _____ DATE _____

Sample Custodian Review: Rebecca Hussong DATE 12/22/05

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSSB-011

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ATTACHMENTS

Final Status Survey Report
Volume V – Pond Parcel Excavation Backfill Units
Sub-Report No. BCM-011
Survey Unit Kaiser-FSSB-011
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
July 12, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation backfill unit final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility **(Figure 1)**. Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSSB-011, which consists of a unit of Below Criteria Material or BCM (less than 31.1 net pCi/g Th-232 material) placed in an excavation resulting from the removal of radiologically-affected soil from the Retention Pond area. Survey Unit Kaiser-FSSB-011 is considered a Class 1 survey unit with an approximate base surface area of 1,754 m^2. It is located on the north side of the pond parcel within portions of excavation bottoms associated with Survey Units Kaiser-FSS-006, Kaiser-FSS-011, Kaiser-FSS-022, Kaiser-FSS-023, and Kaiser-FSS-024 **(Figure 3)**. The survey unit is bordered by excavation backfill Survey Unit Kaiser-FSSB-009 to the north, excavation backfill Survey Unit Kaiser-FSSB-002 to the west, excavation backfill Survey Unit Kaiser-FSSB-010 to the east, and excavation backfill Survey Units Kaiser-FSSB-014 and Kaiser-FSSB-015 to the south.

A total of four 2-foot layers (lifts) of BCM was placed in Survey Unit Kaiser-FSSB-011.

Separate distinct final status surveys were completed for the pond parcel excavation bottom survey units prior to backfilling with BCM. The final status survey of the pond parcel excavation bottom survey units is documented in **Volumes I and IV** of the Final Status Survey Report.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the BCM placed within Survey Unit Kaiser-FSSB-011. The final status survey consisted of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit.

2.1 Gross Gamma Scan

Each 2-foot lift of BCM was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of each lift, the detector was held close to the BCM surface (1 to 2 inches) and moved in a serpentine pattern. Approximate equal-distant background measurements were also obtained at 1-meter above the ground surface for each lift of BCM placed. A statistical summary of the background survey and 100 percent coverage gamma scan of each BCM lift placed in the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Name	Date	Lift Area (m^2)	No. of 2-sec. Scans	Scan Rate (m/s)	Ave. (cpm)	Std. Dev. (cpm)	Min. (cpm)	Max. (cpm)	Median (cpm)
1st lift Scan	2/02/06	1,754	1,801	0.49	39,565	3,846	20,991	73,559	40,068
1st lift Bkgrd.	2/02/06	1,754	15	N/A	38,470	1,567	35,347	41,020	38,139
2nd lift Scan	2/04/06	1,582	1,580	0.50	40,320	4,189	22,161	74,111	40,920
2nd lift Bkgrd.	2/04/06	1,582	15	N/A	39,008	1,318	36,470	40,714	38,853
3rd lift Scan	2/08/06	1,425	1,777	0.40	39,556	4,055	22,193	58,281	39,977
3rd lift Bkgrd.	2/08/06	1,425	15	N/A	37,581	3,089	27,976	41,192	38,242
4th lift Scan	2/14/06	1,281	1,561	0.41	38,743	3,401	22,913	54,847	39,065
4th lift Bkgrd.	2/14/06	1,281	10	N/A	37,628	844	36,211	38,796	37,464

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented by BCM lift on **Figures A-1 through A-4** contained in **Attachment A.** The 100 percent coverage gross gamma scan of the 2-foot lifts did not indicate the presence of small areas (1 m^2) of elevated activity (above the DCCL for the site).

2.2 Systematic Soil Core Sampling

The final status survey also consisted of systematic soil core sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Core Samples (core holes) Required (N) based on the scan MDC was determined to be 9, as documented on Soil Survey Unit Worksheet No. 1 (**Attachment B**). Once N was determined, the Survey Unit Area (A) of 1,754 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 15.0 meters and the Height of the Equilateral Triangle (h) of 13.0 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 (**Attachment B**).

A layout of the soil sampling locations is provided on **Figure A-5** contained in **Attachment A**. The soil core sample locations were demarcated in the field using a GPS unit. A total of 11 core holes (sample locations) were installed on the grid prescribed over the survey unit (Cores Nos. 1 through 11). Core segments of BCM (typically 3 feet in length) were scanned in the field in 1-foot increments. The 1-foot increments were also characterized by a 1 minute static count of gross gamma activity. The results are presented below in **Table 2**.

Table 2 - Soil Core Segment Gross Gamma Survey Results

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
1	A	36	1	19	19,524	1,300
1	A		2	19	19,213	989
1	A		3	19	19,010	786
2	A	48	1	21	20,173	1,949
2	A		2	21	21,627	3,403
2	A		3	19	19,141	917
2	A		4	20	20,428	2,204
3	A	36	1	19	20,103	1,879
3	A		2	20	20,288	2,064
3	A		3	20	19,884	1,660
3	B	24	4	17	18,416	192
3	B		5	17	19,455	1,231
4	A	48	1	19	19,797	1,573
4	A		2	21	20,085	1,861
4	A		3	21	19,862	1,638
4	A		4	20	20,813	2,589
5	A	36	1	20	19,929	1,705
5	A		2	21	21,559	3,335
5	A		3	21	19,305	1,081
5	B	48	4	19	20,060	1,836
5	B		5	20	20,184	1,960
5	B		6	20	20,595	2,371
5	B		7	20	20,242	2,018
6	A	36	1	20	21,160	2,936

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
6	A		2	22	20,730	2,506
6	A		3	22	21,434	3,210
6	B	48	4	19	20,856	2,632
6	B		5	20	20,725	2,501
6	B		6	20	20,752	2,528
6	B		7	21	20,546	2,322
7	A	36	1	20	20,629	2,405
7	A		2	21	21,066	2,842
7	A		3	22	21,686	3,462
7	B	48	4	19	20,003	1,779
7	B		5	20	20,513	2,289
7	B		6	20	19,985	1,761
7	B		7	21	21,701	3,477
8	A	36	1	19	20,503	2,279
8	A		2	21	20,711	2,487
8	A		3	20	21,094	2,870
8	B	36	4	20	19,693	1,469
8	B		5	19	19,896	1,672
8	B		6	19	18,300	76
9	A	36	1	19	19,723	1,499
9	A		2	19	20,983	2,759
9	A		3	21	20,436	2,212
9	B	36	4	19	20,011	1,787
9	B		5	20	21,715	3,491
9	B		6	20	21,687	3,463
9	C	24	7	19	19,844	1,620
9	C		8	20	19,975	1,751
10	A	36	1	21	20,784	2,560
10	A		2	21	21,259	3,035
10	A		3	21	21,240	3,016
10	B	36	4	20	20,301	2,077
10	B		5	20	21,852	3,628
10	B		6	21	20,562	2,338
10	C	36	7	19	19,296	1,072
10	C		8	20	20,245	2,021
10	C		9	20	20,115	1,891
11	A	36	1	21	21,262	3,038
11	A		2	22	21,325	3,101
11	A		3	22	21,465	3,241
11	B	36	4	19	19,350	1,126
11	B		5	20	20,550	2,326
11	B		6	19	20,297	2,073
11	C	36	7	21	20,558	2,334

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
11	C		8	22	20,937	2,713
11	C		9	22	20,103	1,879
			Count:	*69*	*69*	*69*
			Average:	*20*	*20,399*	*2,175*
			Std. Dev.:	*1.1*	*792*	*792*
			Minimum:	*17*	*18,300*	*76*
			Maximum:	*22*	*21,852*	*3,628*
			Median:	*20*	*20,428*	*2,204*

[1]Net Static Count values (cpm) are equal to the Gross Static Count minus a background value of 18,224 cpm based on the average of 5 consecutive 1-minute counts performed with the detector on top of the table used to scan the cores, prior to scan activities.

A composite sample representing each core segment was then prepared by combining each set of three 1-foot increments in a bucket and breaking up the cores. The final segment of core may be less than or greater than 3 feet depending on the point at which virgin material was encountered. A sample (usually between 500 and 800 grams) was taken from each composite and forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3**. Analytical data reports are contained in **Attachment C**.

Table 3 – Systematic Soil Core Composite Sample Results

Core Number	Core Segment	Segment Length (in.)	Composite Sample No.	Core Depth (ft)	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)[1]
1	A	36	K-1509	1	6.17	0.373	0.256	5.07
2	A	48	K-1510	1	9.63	0.917	0.633	8.53
3	A	36	K-1511	1	7.66	0.542	0.556	6.56
3	B	24	K-1512	4	5.08	0.397	0.311	3.98
4	A	48	K-1513	1	8.00	0.470	0.300	6.90
5	A	36	K-1514	1	6.19	0.578	0.379	5.09
5	B	48	K-1515	4	7.36	0.382	0.312	6.26
6	A	36	K-1516	1	7.72	0.507	0.323	6.62
6	B	48	K-1517	4	8.65	0.796	0.357	7.55
7	A	36	K-1518	1	6.70	0.656	0.689	5.60
7	B	48	K-1519	4	7.15	0.522	0.450	6.05
8	A	36	K-1520	1	5.91	0.289	0.420	4.81
8	B	36	K-1521	4	6.00	0.338	0.298	4.90
9	A	36	K-1522	1	8.30	0.924	0.801	7.20
9	B	36	K-1523	4	7.00	0.531	0.500	5.90
9	C	24	K-1524	7	6.99	0.520	0.320	5.89
10	A	36	K-1525	1	7.11	0.449	0.285	6.01
10	B	36	K-1526	4	9.04	0.856	0.490	7.94
10	C	36	K-1527	7	7.69	0.539	0.434	6.59
11	A	36	K-1528	1	8.35	0.515	0.337	7.25

Core Number	Core Segment	Segment Length (in.)	Composite Sample No.	Core Depth (ft)	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)[1]
11	B	36	K-1529	4	6.59	0.678	0.576	5.49
11	C	36	K-1530	7	7.79	0.317	0.275	6.69
				Count:	*22*		*Count:*	*22*
				Average:	*7.32*		*Average:*	*6.22*
				Std. Dev.:	*1.11*		*Std. Dev.:*	*1.11*
				Minimum:	*5.08*		*Minimum:*	*3.98*
				Maximum:	*9.63*		*Maximum:*	*8.53*
				Median:	*7.26*		*Median:*	*6.16*

[1]Net Th-232 activity concentration (pCi/g) is equal to the Gross Th-232 activity concentration minus the established background value of 1.1 pCi/g Th-232.

The net Th-232 activity concentrations for all 22 systematic composite samples were below the BCM surrogate value of 31.1 pCi/g net Th-232 activity concentration (DCCL). The maximum net Th-232 activity concentration was 8.53 pCi/g. The average net Th-232 activity concentration was 6.22 pCi/g. The standard deviation of the 22 composite samples was 1.11, which fell below the estimated standard deviation of 4.4 used to calculate the minimum number of samples required in the decommissioning plan.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil core composite samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit core sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (8.99 pCi/g) between the maximum survey unit soil sample gross activity concentration (9.63 pCi/g) and the minimum reference background area soil sample activity concentration (0.64 pCi/g) is less than DCCL (31.1 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Gross Th-232 (pCi/g)
R1	272	1.43	S1	K-1509	6.17
R2	185	0.90	S2	K-1510	9.63
R3	277	1.12	S3	K-1511	7.66
R4	337	1.21	S4	K-1512	5.08
R5	173	0.86	S5	K-1513	8.00
R6	12	0.96	S6	K-1514	6.19
R7	92	1.37	S7	K-1515	7.36
R8	52	1.63	S8	K-1516	7.72

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Gross Th-232 (pCi/g)
R9	214	1.45	S9	K-1517	8.65
R10	106	0.98	S10	K-1518	6.70
R11	134	0.75	S11	K-1519	7.15
R12	355	0.96	S12	K-1520	5.91
R13	67	1.18	S13	K-1521	6.00
R14	29	0.90	S14	K-1522	8.30
R15	144	1.28	S15	K-1523	7.00
R16	73	1.09	S16	K-1524	6.99
R17	103	1.12	S17	K-1525	7.11
R18	345	0.86	S18	K-1526	9.04
R19	82	1.43	S19	K-1527	7.69
R20	177	0.64	S20	K-1528	8.35
R21	204	1.35	S21	K-1529	6.59
R22	223	1.02	S22	K-1530	7.79
	Average:	***1.11***		***Average:***	***7.32***
	Std. Dev.	***0.26***		***Std. Dev.***	***1.11***
	Minimum:	***0.64***		***Minimum:***	***5.08***
	Maximum:	***1.63***		***Maximum:***	***9.63***
	Median:	***1.11***		***Median:***	***7.26***

3.0 SUMMARY OF FINDINGS

Survey Unit Kaiser-FSSB-011, which consists of a unit of BCM placed in an excavation resulting from the removal of radiologically-affected soil from the Retention Pond area, is considered a Class 1 survey unit with an approximate base surface area of 1,754 m^2. It is located on the north side of the pond parcel within portions of excavation bottoms associated with Survey Units Kaiser-FSS-006, Kaiser-FSS-011, Kaiser-FSS-022, Kaiser-FSS-023, and Kaiser-FSS-024 (**Figure 3**). The survey unit is bordered by excavation backfill Survey Unit Kaiser-FSSB-009 to the north, excavation backfill Survey Unit Kaiser-FSSB-002 to the west, excavation backfill Survey Unit Kaiser-FSSB-010 to the east, and excavation backfill Survey Units Kaiser-FSSB-014 and Kaiser-FSSB-015 to the south.

A total of four 2-foot layers (lifts) of BCM was placed in Survey Unit Kaiser-FSSB-011.

The acceptance criterion for BCM survey units at the Tulsa facility is the DCCL of 31.1 pCi/g net Th-232 activity concentration. The final status survey consisted of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan of each lift (final as-left condition) did not indicate the presence of small areas (1 m^2) of elevated activity (greater than the DCCL for the site).
- The net Th-232 activity concentrations for all 22 systematic composite core samples were below the BCM surrogate value of 31.1 pCi/g net Th-232 activity concentration (DCCL).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).

The results of the final status survey activities show that Survey Unit Kaiser-FSSB-011 meets the DP acceptance criteria.

ATTACHMENT A
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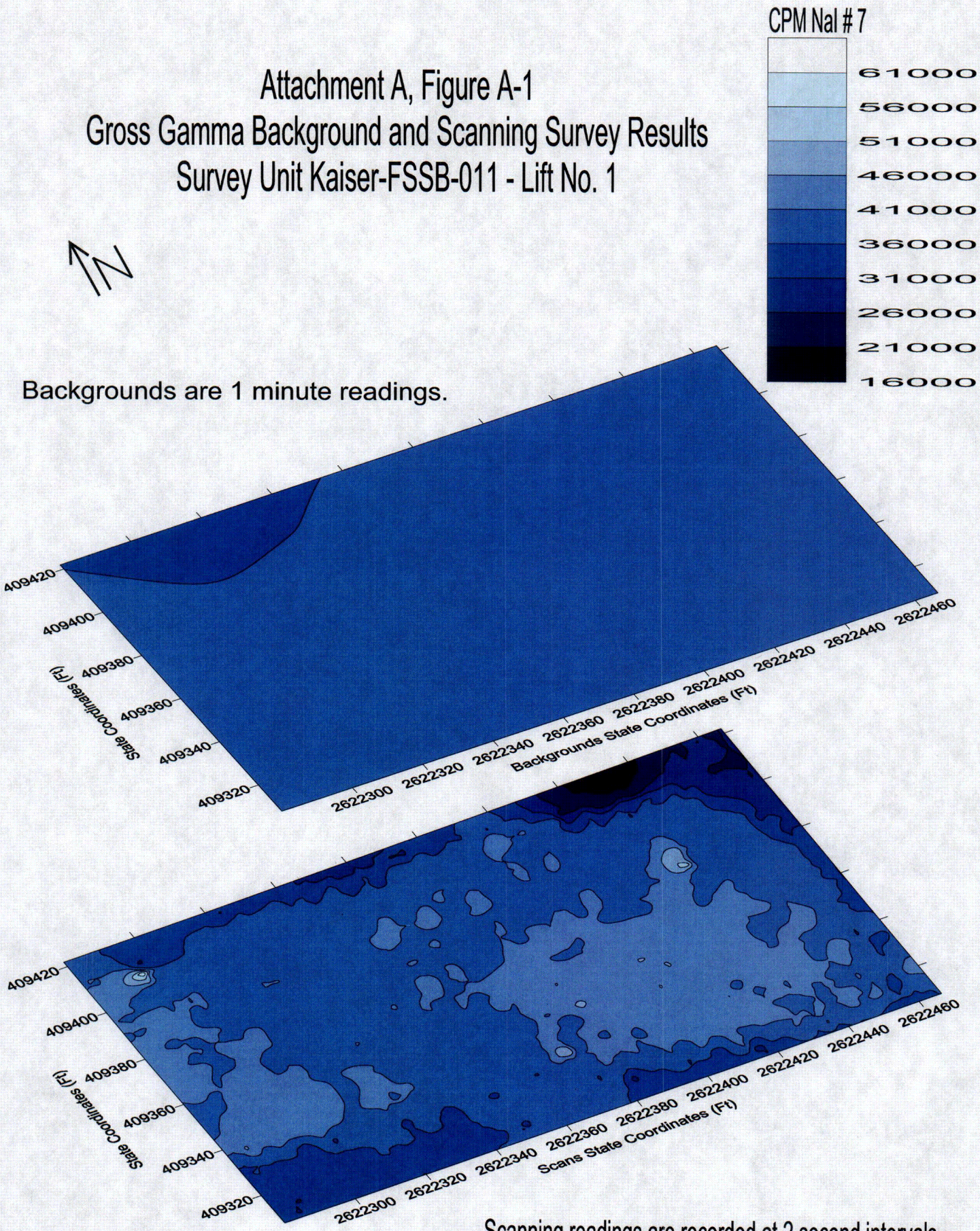
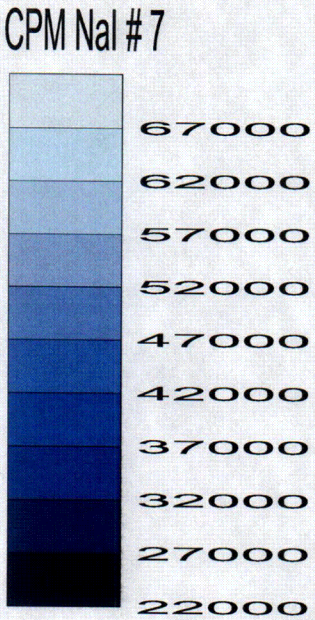
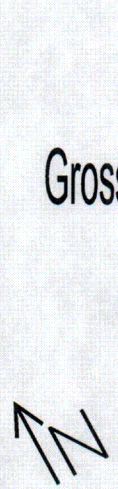
Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-011 - Lift No. 1

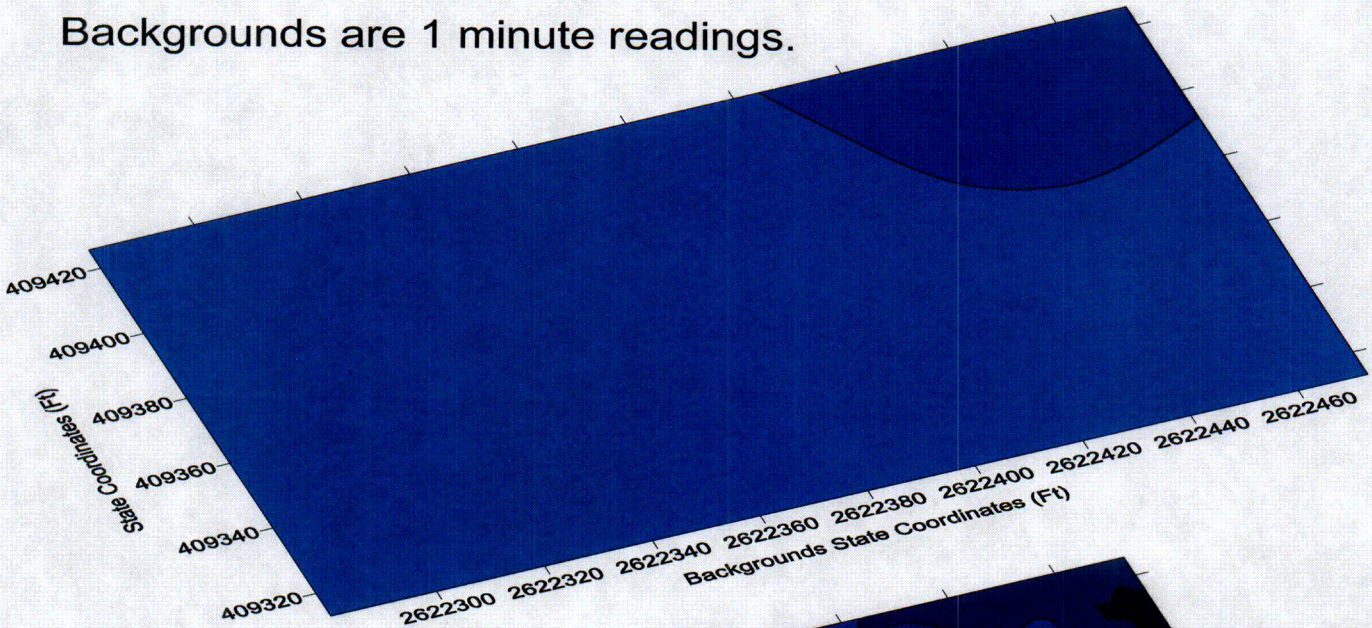


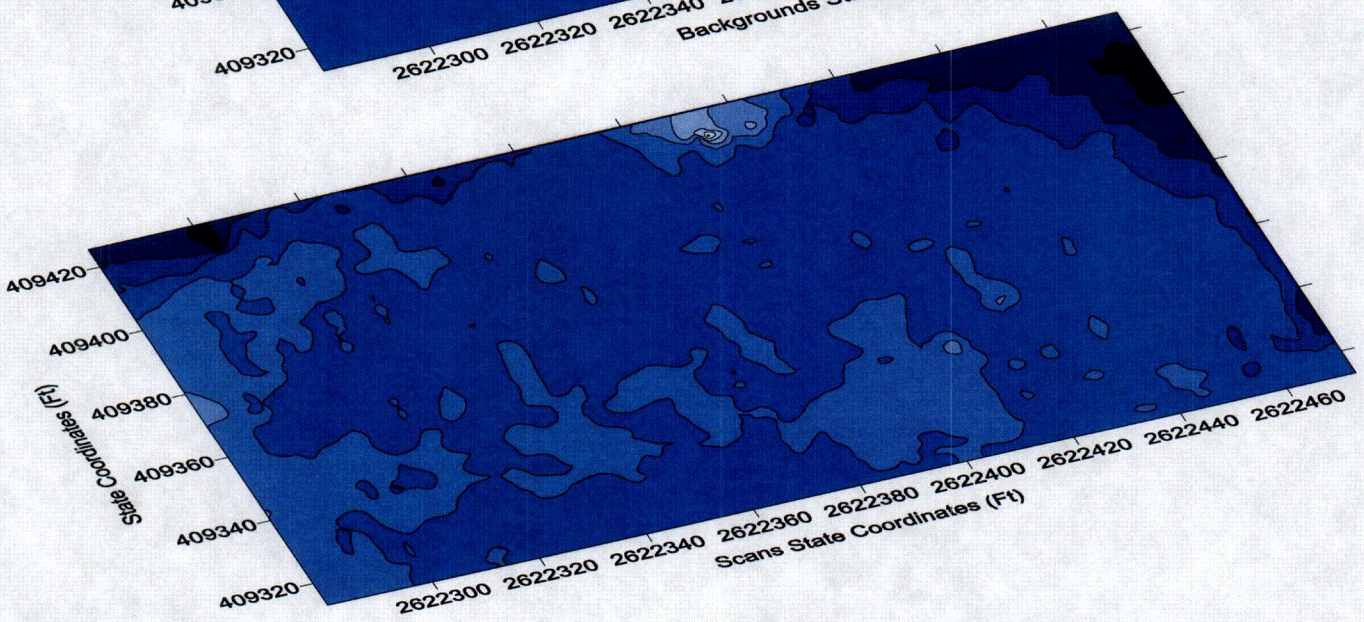
Attachment A, Figure A-2
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-011 - Lift No. 2





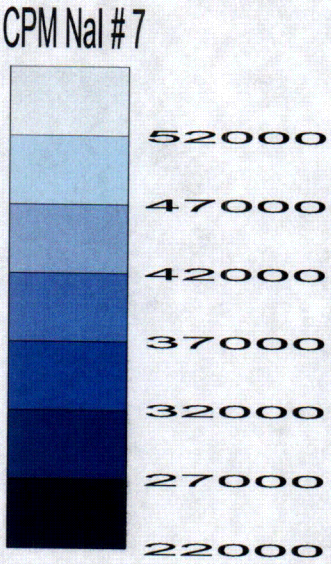
Backgrounds are 1 minute readings.

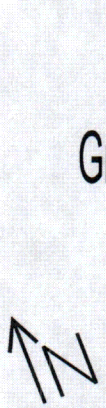




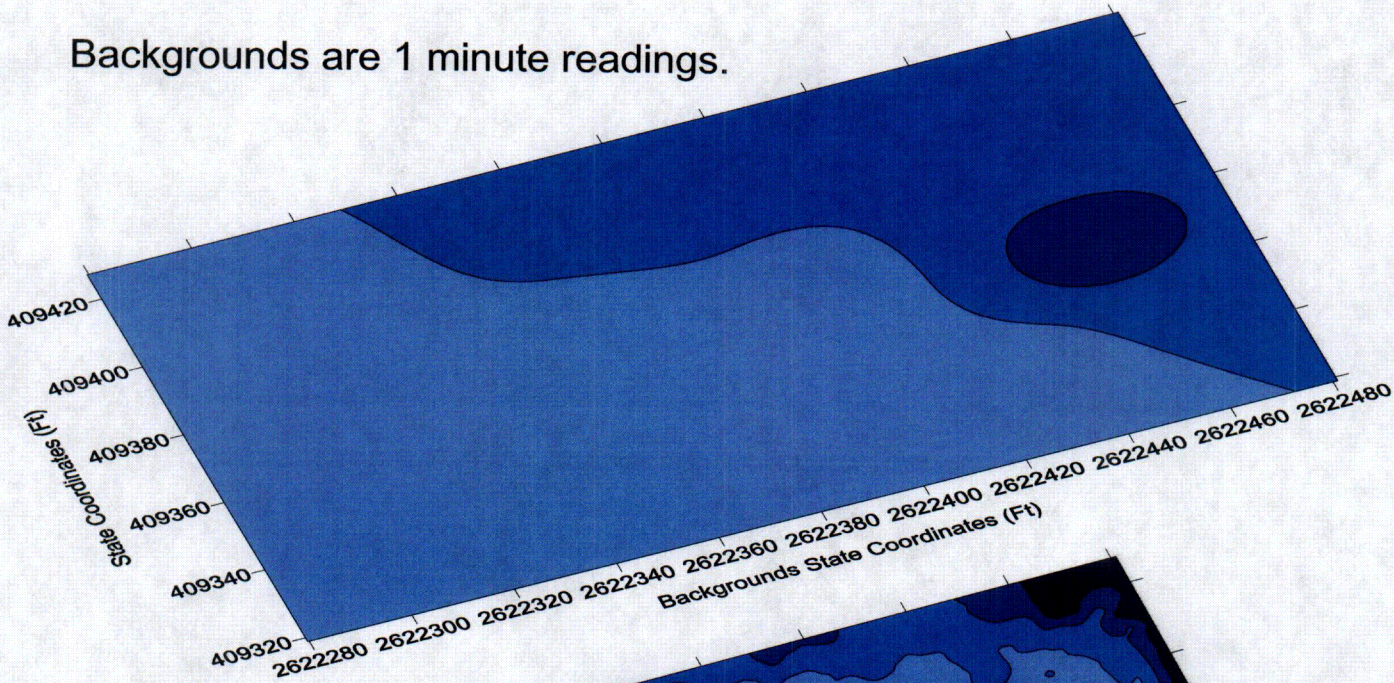
Scanning readings are recorded at 2 second intervals.

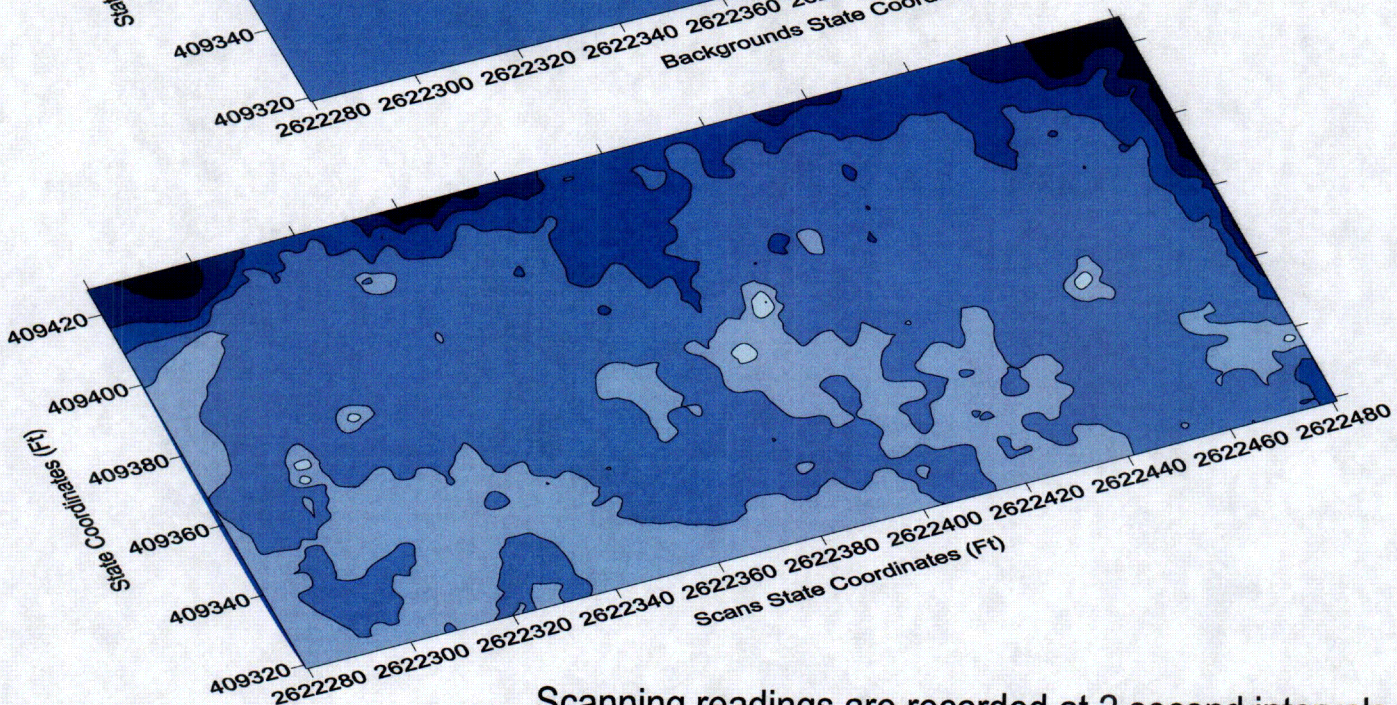
Attachment A, Figure A-3
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-011 - Lift No. 3





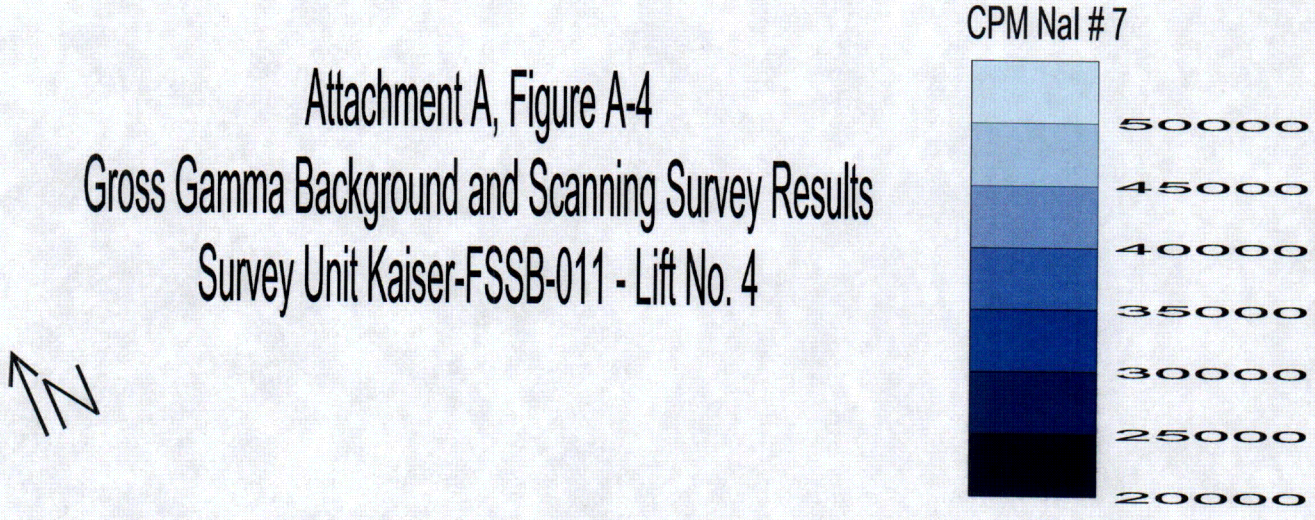
Backgrounds are 1 minute readings.



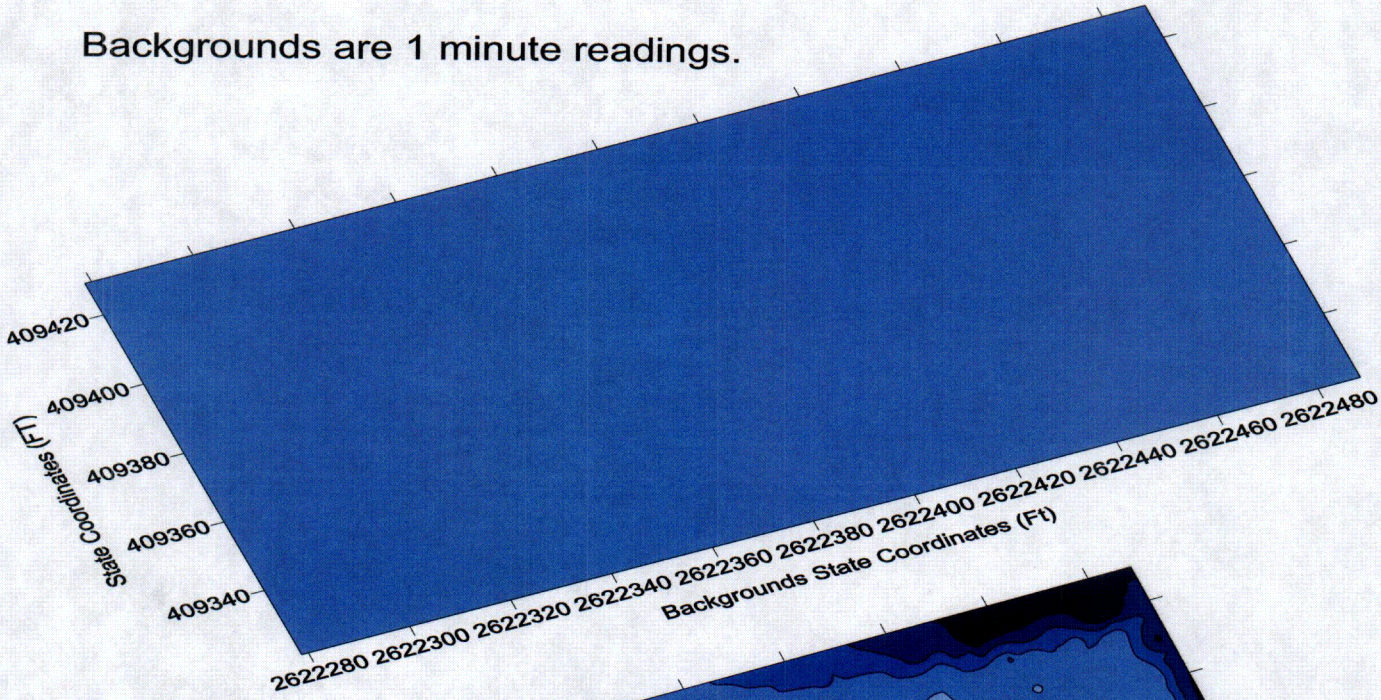


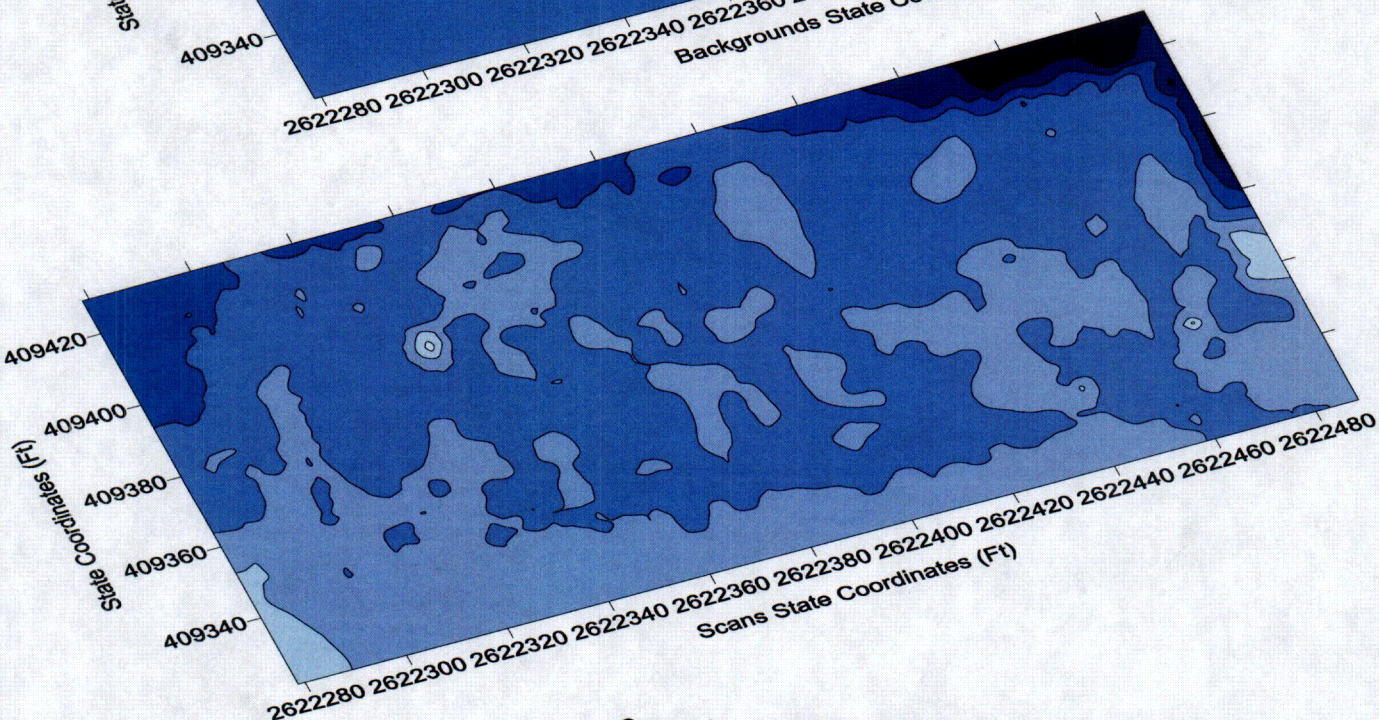
Scanning readings are recorded at 2 second intervals.

Attachment A, Figure A-4
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-011 - Lift No. 4

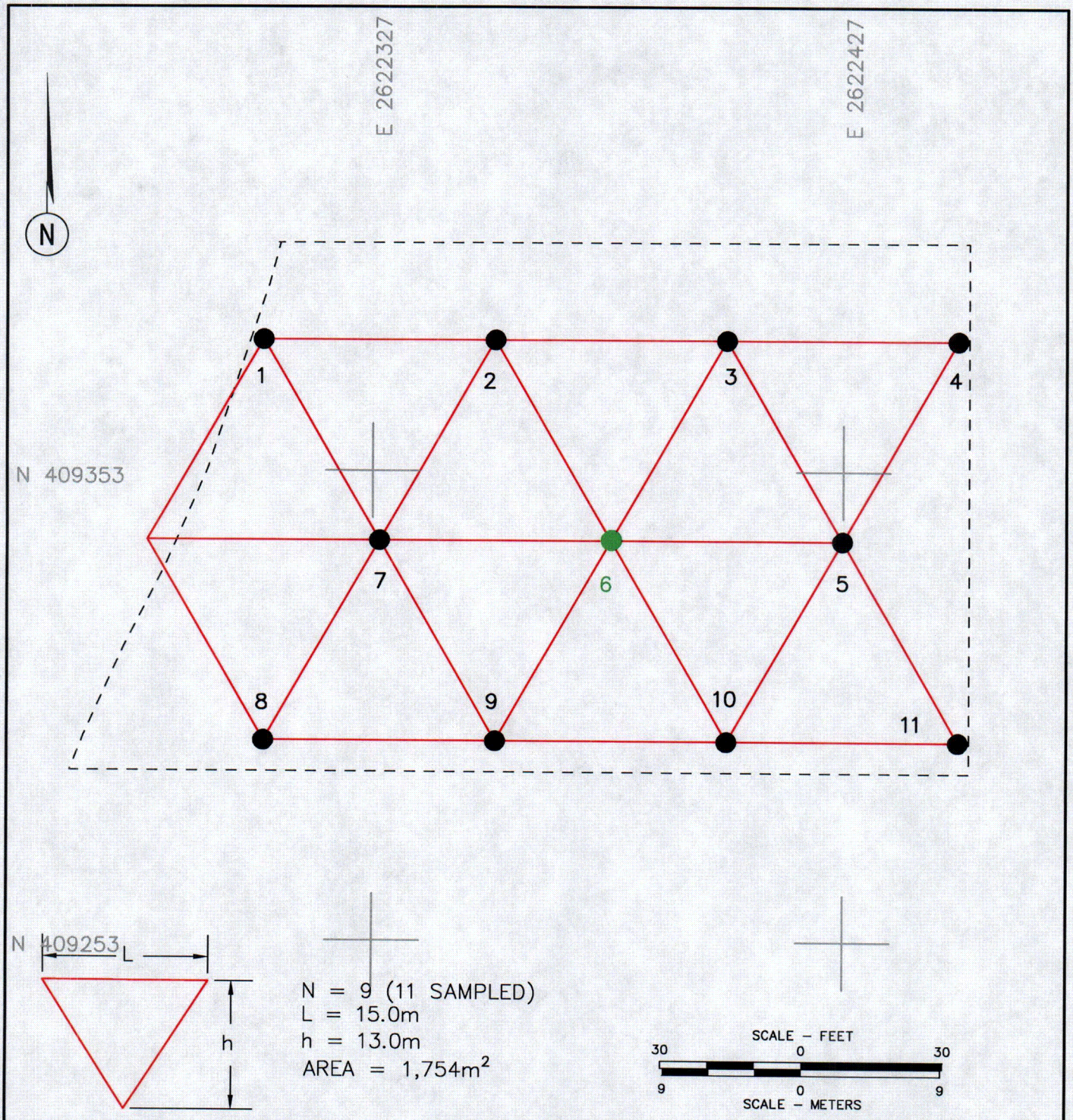


Backgrounds are 1 minute readings.





Scanning readings are recorded at 2 second intervals.



1 ● SYSTEMATIC SOIL CORE SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

6 ● RANDOM START POINT

FIGURE A–5
SYSTEMATIC SOIL CORE SAMPLING LOCATIONS SURVEY UNIT KAISER – FSSB–011 FINAL STATUS SURVEY THORIUM REMEDIATION PROJECT TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RFD 7-12-06
CHECKED	RFD 7-12-06
DRAWN	DEB 05/26/06
DRAWING NUMBER	PA4072077A

Penn E&R
Environmental & Remediation, Inc.

H:\4000-PA...2\PA4072077A.dwg, 7/11/2006 10:15:41 AM

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: Kaiser-FSSB-011

2. Description: Pond Parcel Excavation Backfill Unit

3. Net Th-232 Acceptance Criteria (pCi/g): 31.1

4. Dimensions (m): Approximately 52 meters x 34 meters; Area, A (m^2): 1,754

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 75,000 Minimum: 50,000 Maximum: 100,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 5.7
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 15.0

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 13.0 m.

1

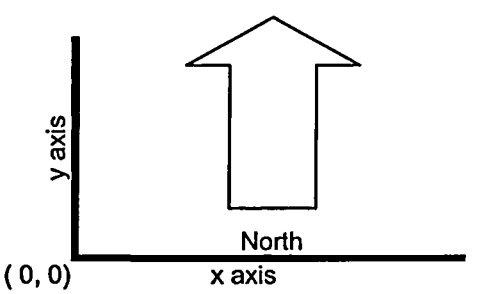
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSSB-011

RANDOM START POINT

x axis (Meters)	y axis (Meters)
35	15

	x axis	y axis
lower bound	0	0
upper bound	52	34



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach
Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Inv # 11875
DJ - 03/27/06

March 23, 2006

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20060143

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on February 20, 2006 for the above captioned project. Twenty-three soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with a standard 20-work day turn. Results were faxed on 3/20/06.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060143
Date Reported:	3/23/06
Date Received:	2/20/06
Page Number:	1 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20060143-01**						
Client ID:	**K-1509**						
Date Sampled:	**2/17/06 8:03:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	6.17 +/- 0.373	pCi/g	0.256		2/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.8	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-02**						
Client ID:	**K-1510**						
Date Sampled:	**2/17/06 8:30:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	9.63 +/- 0.917	pCi/g	0.633		2/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.9	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-03**						
Client ID:	**K-1511**						
Date Sampled:	**2/17/06 8:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	7.66 +/- 0.542	pCi/g	0.556		3/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.4	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-04**						
Client ID:	**K-1512**						
Date Sampled:	**2/17/06 8:43:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	5.08 +/- 0.397	pCi/g	0.311		2/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.5	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-05**						
Client ID:	**K-1513**						
Date Sampled:	**2/17/06 8:48:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach
boratory
North Aspen
Broken Arrow, OK 74012
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FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060143
Date Reported:	3/23/06
Date Received:	2/20/06
Page Number:	2 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Th-232	HASL 300	8.00 +/- 0.470	pCi/g	0.300		2/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.6	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-06**						
Client ID:	**K-1514**						
Date Sampled:	**2/17/06 9:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	6.19 +/- 0.578	pCi/g	0.379		2/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.2	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-07**						
Client ID:	**K-1515**						
te Sampled:	**2/17/06 9:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	7.36 +/- 0.382	pCi/g	0.312		3/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.7	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-08**						
Client ID:	**K-1516**						
Date Sampled:	**2/17/06 9:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	7.72 +/- 0.507	pCi/g	0.323		2/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.3	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-09**						
Client ID:	**K-1517**						
Date Sampled:	**2/17/06 9:25:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	8.65 +/- 0.796	pCi/g	0.357		2/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.4	%		2/20/06	2/21/06	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
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Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060143
Date Reported:	3/23/06
Date Received:	2/20/06
Page Number:	3 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20060143-10**						
Client ID:	**K-1518**						
Date Sampled:	**2/17/06 9:35:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	6.70 +/- 0.656	pCi/g	0.689		3/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.5	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-11**						
Client ID:	**K-1519**						
Date Sampled:	**2/17/06 9:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	7.15 +/- 0.522	pCi/g	0.450		2/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.1	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-12**						
Client ID:	**K-1520**						
Date Sampled:	**2/17/06 9:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	5.91 +/- 0.289	pCi/g	0.420		3/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.4	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-13**						
Client ID:	**K-1521**						
Date Sampled:	**2/17/06 9:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	6.00 +/- 0.338	pCi/g	0.298		2/21/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.3	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-14**						
Client ID:	**K-1522**						
Date Sampled:	**2/17/06 10:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

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Broken Arrow, OK 74012
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FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060143
Date Reported:	3/23/06
Date Received:	2/20/06
Page Number:	4 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Th-232	HASL 300	8.30 +/- 0.924	pCi/g	0.801		2/21/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.0	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-15**						
Client ID:	**K-1523**						
Date Sampled:	**2/17/06 10:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	7.00 +/- 0.531	pCi/g	0.500		2/21/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.8	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-16**						
Client ID:	**K-1524**						
Date Sampled:	**2/17/06 10:15:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	6.99 +/- 0.520	pCi/g	0.320		3/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.8	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-17**						
Client ID:	**K-1525**						
Date Sampled:	**2/17/06 10:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	7.11 +/- 0.449	pCi/g	0.285		2/21/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.9	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-18**						
Client ID:	**K-1526**						
Date Sampled:	**2/17/06 10:30:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	9.04 +/- 0.856	pCi/g	0.490		2/21/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.8	%		2/20/06	2/21/06	RT

BDL = Below Detection Limit

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Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20060143-19**						
Client ID:	**K-1527**						
Date Sampled:	**2/17/06 10:35:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	7.69 +/- 0.539	pCi/g	0.434		2/21/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.9	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-20**						
Client ID:	**K-1528**						
Date Sampled:	**2/17/06 10:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
-232	HASL 300	8.35 +/- 0.515	pCi/g	0.337		2/21/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.4	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-21**						
Client ID:	**K-1529**						
Date Sampled:	**2/17/06 10:45:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	6.59 +/- 0.678	pCi/g	0.576		3/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.4	%		2/20/06	2/21/06	RT
Lab ID:	**20060143-22**						
Client ID:	**K-1530**						
Date Sampled:	**2/17/06 10:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	7.79 +/- 0.317	pCi/g	0.275		3/20/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.7	%		2/20/06	2/21/06	RT
b ID:	**20060143-23**						
Client ID:	**K-1531**						
Date Sampled:	**2/17/06 11:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach
Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060143
Date Reported:	3/23/06
Date Received:	2/20/06
Page Number:	6 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Th-232	HASL 300	0.668 +/- 0.171	pCi/g	0.234		2/21/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.6	%		2/20/06	2/21/06	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					2.0				3/20/06
Ac-228					11.1				2/20/06
Am-241		91.0	89.0	2.8					3/20/06
Am-241		86.0	92.0	6.5					2/20/06
Co-60		93.0	94.0	0.6					3/20/06
-60		91.0	94.0	3.6					2/20/06
Cs-137		95.0	94.0	1.0					3/20/06
Cs-137		92.0	95.0	3.7					2/20/06
Percent Moisture					4.4				2/21/06
Percent Moisture					16.0				2/21/06

Lab Approval:

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Local: 918-384-0561 Cell: 724-799-0071
Company: Kaiser Alum & Chem Inc.
Name: David G. Weyant
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3530 Fax #: 918-384-3171

Bill To:
Company: Kaiser / Esan EGR
Name: Paul Hanna / David G. Weyant
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser-Horizon Remed.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 20 Days.
SAMPLER: David G. Weyant (Signature)

PRESERVATIVE #: 1. HNO_3 pH<2 2. Ice <4°C 3. HCl pH<2 4. H_2SO_4 pH<2 5. NaOH pH>11

FOR LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE PLASTIC OR GLASS	PRESERVATIVE #	Gamma Spec (L-232)	Return to Client for Analysis	MOC < 0.5 Dry/Air	ASTM D2216-92 Moist. Content					REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1509	2-17-06	0803	Soil	1	500ml Plastic	None	X	X	X	X					GRAB
	K-1510		0830		1			X	X	X	X					
	K-1511		0840		1			X	X	X	X					
	K-1512		0843		1			X	X	X	X					
	K-1513		0848		1			X	X	X	X					
	K-1514		0900		1			X	X	X	X					
	K-1515		0905		1			X	X	X	X					
	K-1516		0920		1			X	X	X	X					
	K-1517		0925		1			X	X	X	X					
	K-1518		0935		1			X	X	X	X					
	K-1519		0940		1			X	X	X	X					
	K-1520		0950		1			X	X	X	X					
	K-1521		0955		1			X	X	X	X					
	K-1522		1000		1			X	X	X	X					

N/A

RELINQUISHED BY: David G. Weyant DATE: 2/20/06 TIME: 830 RECEIVED BY: Ron Sibson DATE: 2/20/06 TIME: 830

RELINQUISHED BY: ____ DATE: ____ TIME: ____ RECEIVED BY: ____ DATE: ____ TIME: ____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 0602145-1
Sample Condition Upon Receipt: Good
Custody Seals Intact: Y / N
Cooler Temperature: N/A

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN CUSTODY

Results To:
Company Kaiser - Mom & Chem Inc.
Name David B. Weyant
Address 7311 E. 41st St.
City Tulsa State OK Zip 74145
Phone 724-934-3373 Fax # 918 384 7171

Loc M: 918-384-0566
Cell: 724-799-0071

Bill To:
Company Kaiser / Penn Eng
Name Pat Hanna / David B. Weyant
Address 7311 E. 41st St.
City Tulsa State OK Zip 74145

ANALYSIS REQUESTED

PO # Kaiser - 4072
PROJECT # PA - 4000 - 4072
PROJECT NAME Kaiser - Thorium Remo.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 20 DAYS.
SAMPLER Signature
DAVID B. WEYANT

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2, 2. Ice <4°C, 3. HCl pH<2, 4. H_2SO_4 pH<2, 5. NaOH pH>11)	GAMMA SPEC (Th-232)	Ra-226 to Client for Analysis	RAD < 0.5 PCi/gm	ASTM D-2216-92 Moisture Content	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1523	2-17-06	10:10	Soil	1	500ml Plastic	None	X	X	X	X	Grab
	K-1524		10:15		1			X	X	X	X	
	K-1525		10:20		1			X	X	X	X	
	K-1526		10:30		1			X	X	X	X	
	K-1527		10:35		1			X	X	X	X	
	K-1528		10:40		1			X	X	X	X	
	K-1529		10:45		1			X	X	X	X	
	K-1530		10:50		1			X	X	X	X	
	K-1531		11:10		1			X	X	X	X	Comp
		N										
			A				N					
								A				

RELINQUISHED BY: DAVID B. WEYANT DATE 2/20/06 TIME 830 RECEIVED BY: DATE 2/20/06 TIME 830

RELINQUISHED BY: DATE TIME RECEIVED BY: DATE TIME

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 2-21-06 1432
Sample Condition Upon Receipt: Good
Custody Seal Intact: Yes No N/A
Cooler Temperature: N/A °C

SAMPLE RECEIPT

Date Received: 2/20/06 9:07:16 A Lab Number: 20060143 Due: 3/20/06

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20060143-01 A	K-1509	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060143-02 A	K-1510	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060143-03 A	K-1511	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060143-04 A	K-1512	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060143-05 A	K-1513	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060143-06 A	K-1514	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060143-07 A	K-1515	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060143-08 A	K-1516	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060143-09 A	K-1517	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060143-10 A	K-1518	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes

Th-232 by Gamma Spec								
20060143-11 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1519	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
20060143-12 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1520	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
20060143-13 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1521	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
20060143-14 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1522	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
20060143-15 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1523	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
20060143-16 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1524	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
20060143-17 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1525	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
20060143-18 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1526	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
20060143-19 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1527	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
20060143-20 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-1528	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes

Percent ure (LOD) Th-232 amma Spec								
20060143-22 A	K-1530	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD) Th-232 by Gamma Spec								
20060143-23 A	K-1531	Soil	02/17/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD) Th-232 by Gamma Spec								

CONTAINER INSPECTION

 # Coolers 1 **Custody Seals Broken** ☐ **Temperature:** C Ice **Radiation Survey:** <300 cpm

SAMPLE INSPECTION

Sample Seal Broken NA **Chain of Custody Record** ☑ **Labels in Tact** ☑ **Radiation Survey Complete** ☑

Anomalies

Inspected By: _____ **DATE** _____

QA or Designee Review: Raymond Thomas **DATE** 02/20/07

Sample Custodian Review: [signature] **DATE** 2/20/06

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSSB-012

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume V – Pond Parcel Excavation Backfill Units
Sub-Report No. BCM-012
Survey Unit Kaiser-FSSB-012
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
July 12, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation backfill unit final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility **(Figure 1)**. Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSSB-012, which consists of a unit of Below Criteria Material or BCM (less than 31.1 net pCi/g Th-232 material) placed in an excavation resulting from the removal of radiologically-affected soil from the Retention Pond area. Survey Unit Kaiser-FSSB-012 is considered a Class 1 survey unit with an approximate base surface area of 1,840 m^2. It is located in the center of the pond parcel within portions of excavation bottoms associated with Survey Units Kaiser-FSS-018, Kaiser-FSS-019, Kaiser-FSS-023, and Kaiser-FSS-028 **(Figure 3)**. The survey unit is bordered by excavation backfill Survey Unit Kaiser-FSSB-010 to the north, excavation backfill Survey Unit Kaiser-FSSB-013 to the west, excavation backfill Survey Units Kaiser-FSSB-007 and Kaiser-FSSB-008 to the east, and a wall of non-impacted soil (clean import borrow material) to the south).

A total of seven 2-foot layers (lifts) of BCM was placed in Survey Unit Kaiser-FSSB-012.

Separate distinct final status surveys were completed for the pond parcel excavation bottom survey units prior to backfilling with BCM. The final status survey of the pond parcel excavation bottom survey units is documented in **Volumes I and IV** of the Final Status Survey Report.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the BCM placed within Survey Unit Kaiser-FSSB-012. The final status survey consisted of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit.

2.1 Gross Gamma Scan

Each 2-foot lift of BCM was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of each lift, the detector was held close to the BCM surface (1 to 2 inches) and moved in a serpentine pattern. Approximate equal-distant background measurements were also obtained at 1-meter above the ground surface for each lift of BCM placed. A statistical summary of the background survey and 100 percent coverage gamma scan of each BCM lift placed in the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Name	Date	Lift Area (m^2)	No. of 2-sec. Scans	Scan Rate (m/s)	Ave. (cpm)	Std. Dev. (cpm)	Min. (cpm)	Max. (cpm)	Median (cpm)
1st lift Scan	2/15/06	980	1,125	0.44	38,890	4,525	17,838	54,302	40,020
1st lift Bkgrd.	2/15/06	980	8	N/A	38,225	1,551	34,987	40,275	38,555
2nd lift Scan	2/20/06	1,840	2,286	0.40	40,135	9,554	15,145	55,954	41,874
2nd lift Bkgrd.	2/20/06	1,840	14	N/A	41,530	4,730	34,340	49,816	40,455
3rd lift Scan	2/22/06	1,490	1,270	0.59	41,376	8,179	19,760	77,743	42,962
3rd lift Bkgrd.	2/22/06	1,490	14	N/A	42,754	1,571	39,808	45,020	42,843
4th lift Scan	2/24/06	1,340	1,541	0.43	56,890	8,597	31,303	78,607	57,976
4th lift Bkgrd.	2/24/06	1,340	12	N/A	56,707	5,355	45,205	64,349	56,472
5th lift Scan	2/27/06	1,205	1,322	0.46	54,138	6,867	26,433	71,412	53,291
5th lift Bkgrd.	2/27/06	1,205	12	N/A	51,356	3,412	47,909	58,108	50,080
6th lift Scan	3/01/06	1,090	1,329	0.41	43,755	4,730	27,492	75,499	43,395
6th lift Bkgrd.	3/01/06	1,090	12	N/A	41,771	2,666	38,452	46,434	41,804
7th lift Scan	3/03/06	1,090	1,357	0.41	40,366	3,929	30,948	57,142	39,791
7th lift Bkgrd.	3/03/06	1,090	12	N/A	37,340	1,827	34,881	40,191	37,011

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented by BCM lift on **Figures A-1 through A-7** contained in **Attachment A.** The 100 percent coverage gross gamma scan of the 2-foot lifts did not indicate the presence of small areas (1 m^2) of elevated activity (above the DCCL for the site).

2.2 Systematic Soil Core Sampling

The final status survey also consisted of systematic soil core sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Core Samples (core holes) Required (N) based on the scan MDC was determined to be 9, as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B).** Once N was determined, the Survey Unit Area (A) of 1,840 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 15.4 meters and the Height of the Equilateral Triangle (h) of 13.3 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B).**

A layout of the soil sampling locations is provided on **Figure A-8** contained in **Attachment A.** The soil core sample locations were demarcated in the field using a GPS unit. A total of 9 core holes (sample locations) were installed on the grid prescribed over the survey unit (Cores Nos. 1 through 9). Core segments of BCM (typically 3 feet in length) were scanned in the field in 1-foot increments. The 1-foot increments were also characterized by a 1 minute static count of gross gamma activity. The results are presented below in **Table 2.**

Table 2 - Soil Core Segment Gross Gamma Survey Results

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
1	A	36	1	18	19,954	3,058
1	A		2	20	20,097	3,201
1	A		3	18	20,319	3,423
1	B	36	4	19	19,866	2,970
1	B		5	20	19,313	2,417
1	B		6	20	21,748	4,852
1	C	48	7	25	25,602	8,706
1	C		8	27	26,265	9,369
1	C		9	24	26,414	9,518
1	C		10	24	23,361	6,465
2	A	36	1	20	21,419	4,523
2	A		2	20	21,313	4,417
2	A		3	20	23,459	6,563
2	B	36	4	20	21,634	4,738
2	B		5	20	20,349	3,453
2	B		6	20	20,703	3,807
2	C	36	7	18	19,832	2,936
2	C		8	19	18,359	1,463
2	C		9	18	17,252	356
3	A	36	1	20	21,190	4,294

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
3	A		2	23	21,198	4,302
3	A		3	20	23,116	6,220
3	B	36	4	19	21,139	4,243
3	B		5	21	21,600	4,704
3	B		6	20	21,165	4,269
3	C	36	7	26	25,637	8,741
3	C		8	26	21,187	4,291
3	C		9	26	27,678	10,782
3	D	36	10	21	20,505	3,609
3	D		11	22	24,005	7,109
3	D		12	21	29,673	12,777
4	A	36	1	22	21,892	4,996
4	A		2	22	21,721	4,825
4	A		3	22	23,585	6,689
4	B	36	4	19	18,699	1,803
4	B		5	18	18,223	1,327
4	B		6	20	18,577	1,681
4	C	36	7	18	21,180	4,284
4	C		8	19	18,824	1,928
4	C		9	18	20,526	3,630
4	D	36	10	17	17,366	470
4	D		11	17	17,193	297
4	D		12	17	17,644	748
4	E	24	13	16	16,162	-734
4	E		14	16	16,549	-347
5	A	36	1	18	20,005	3,109
5	A		2	20	19,896	3,000
5	A		3	19	20,413	3,517
5	B	36	4	17	19,325	2,429
5	B		5	18	18,410	1,514
5	B		6	17	18,180	1,284
5	C	36	7	21	22,444	5,548
5	C		8	25	24,635	7,739
5	C		9	24	22,811	5,915
5	D	48	10	17	21,541	4,645
5	D		11	22	25,196	8,300
5	D		12	26	26,546	9,650
5	D		13	22	26,743	9,847
6	A	36	1	18	19,432	2,536
6	A		2	20	19,796	2,900
6	A		3	20	20,534	3,638
6	B	36	4	18	19,103	2,207
6	B		5	19	18,822	1,926

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
6	B		6	20	19,676	2,780
6	C	36	7	21	22,558	5,662
6	C		8	22	22,710	5,814
6	C		9	23	22,836	5,940
6	D	36	10	19	19,378	2,482
6	D		11	18	19,373	2,477
6	D		12	19	18,430	1,534
6	E	36	13	19	19,479	2,583
6	E		14	19	19,440	2,544
6	E		15	19	18,909	2,013
7	A	36	1	19	20,519	3,623
7	A		2	21	21,309	4,413
7	A		3	20	21,647	4,751
7	B	36	4	19	20,049	3,153
7	B		5	20	21,807	4,911
7	B		6	20	21,464	4,568
7	C	36	7	19	20,164	3,268
7	C		8	27	28,391	11,495
7	C		9	28	29,829	12,933
7	D	36	10	20	22,489	5,593
7	D		11	22	22,743	5,847
7	D		12	20	23,648	6,752
7	E	24	13	22	21,772	4,876
7	E		14	23	24,753	7,857
8	A	36	1	20	21,557	4,661
8	A		2	22	21,585	4,689
8	A		3	21	22,391	5,495
8	B	36	4	19	21,059	4,163
8	B		5	20	19,753	2,857
8	B		6	19	21,845	4,949
8	C	36	7	24	24,132	7,236
8	C		8	22	22,028	5,132
8	C		9	22	23,491	6,595
8	D	36	10	19	20,697	3,801
8	D		11	19	20,380	3,484
8	D		12	18	19,684	2,788
8	E	36	13	19	19,322	2,426
8	E		14	19	18,959	2,063
8	E		15	19	18,203	1,307
9	A	36	1	20	19,005	2,109
9	A		2	20	20,880	3,984
9	A		3	21	21,197	4,301
9	B	36	4	21	21,069	4,173

Core Number	Core Segment	Segment Length (inches)	Core Depth Below Surface (ft)	Gross Scan Rate (kcpm)	Gross Static Count (cpm)	Net Static Count (cpm)[1]
9	B		5	22	20,952	4,056
9	B		6	22	22,431	5,535
9	C	36	7	22	20,947	4,051
9	C		8	22	20,800	3,904
9	C		9	28	26,157	9,261
9	D	36	10	21	23,094	6,198
9	D		11	22	27,362	10,466
9	D		12	22	21,671	4,775
			Count:	*114*	*114*	*114*
			Average:	*21*	*21,415*	*4,519*
			Std. Dev.:	*2.5*	*2,685*	*2,685*
			Minimum:	*16*	*16,162*	*-734*
			Maximum:	*28*	*29,829*	*12,933*
			Median:	*20*	*21,152*	*4,256*

[1]Net Static Count values (cpm) are equal to the Gross Static Count minus a background value of 16,896 cpm based on the average of 5 consecutive 1-minute counts performed with the detector on top of the table used to scan the cores, prior to scan activities.

A composite sample representing each core segment was then prepared by combining each set of three 1-foot increments in a bucket and breaking up the cores. The final segment of core may be less than or greater than 3 feet depending on the point at which virgin material was encountered. A sample (usually between 500 and 800 grams) was taken from each composite and forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3**. Analytical data reports are contained in **Attachment C**.

Table 3 – Systematic Soil Core Composite Sample Results

Core Number	Core Segment	Segment Length (in.)	Composite Sample No.	Core Depth (ft)	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)[1]
1	A	36	K-1573	1	5.62	0.448	0.427	4.52
1	B	36	K-1574	4	10.6	0.526	0.286	9.50
1	C	48	K-1575	7	19.2	0.900	0.448	18.1
2	A	36	K-1576	1	9.99	0.509	0.363	8.89
2	B	36	K-1577	4	10.4	0.636	0.427	9.30
2	C	36	K-1578	7	5.68	0.436	0.294	4.58
3	A	36	K-1579	1	8.04	0.281	0.304	6.94
3	B	36	K-1580	4	10.8	0.569	0.397	9.70
3	C	36	K-1581	7	14.3	0.709	0.367	13.2
3	D	36	K-1582	10	16.4	0.740	0.343	15.3
4	A	36	K-1583	1	11.0	0.581	0.342	9.90
4	B	36	K-1584	4	10.0	0.660	1.08	8.90
4	C	36	K-1585	7	12.4	1.02	0.860	11.3
4	D	36	K-1586	10	6.72	0.508	0.503	5.62

Core Number	Core Segment	Segment Length (in.)	Composite Sample No.	Core Depth (ft)	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)[1]
4	E	24	K-1587	13	7.11	0.445	0.274	6.01
5	A	36	K-1588	1	11.9	0.817	0.961	10.8
5	B	36	K-1589	4	7.31	0.369	0.261	6.21
5	C	36	K-1590	7	9.07	0.585	0.499	7.97
5	D	48	K-1591	10	19.3	0.966	0.464	18.2
6	A	36	K-1592	1	6.84	0.550	0.719	5.74
6	B	36	K-1593	4	10.6	0.611	0.290	9.50
6	C	36	K-1594	7	13.0	0.760	0.586	11.9
6	D	36	K-1595	10	4.90	0.427	0.291	3.80
6	E	36	K-1596	13	6.41	0.342	0.474	5.31
7	A	36	K-1597	1	7.21	0.400	0.284	6.11
7	B	36	K-1598	4	14.3	0.810	0.445	13.2
7	C	36	K-1599	7	6.90	0.424	0.294	5.80
7	D	36	K-1600	10	16.2	0.839	0.425	15.1
7	E	24	K-1601	13	24.1	1.06	0.608	23.0
8	A	36	K-1602	1	11.7	0.564	0.315	10.6
8	B	36	K-1603	4	10.1	0.422	0.279	9.00
8	C	36	K-1604	7	12.1	0.479	0.358	11.0
8	D	36	K-1605	10	6.41	0.286	0.317	5.31
8	E	36	K-1606	13	5.02	0.447	0.497	3.92
9	A	36	K-1607	1	5.61	0.549	1.06	4.51
9	B	36	K-1608	4	9.84	0.621	0.391	8.74
9	C	36	K-1609	7	1.86	0.240	0.236	0.76
9	D	36	K-1610	10	15.5	1.02	1.51	14.4
				Count:	***38***		***Count:***	***38***
				Average:	***10.4***		***Average:***	***9.30***
				Std. Dev.:	***4.64***		***Std. Dev.:***	***4.64***
				Minimum:	***1.86***		***Minimum:***	***0.76***
				Maximum:	***24.1***		***Maximum:***	***23.0***
				Median:	***10.1***		***Median:***	***9.00***

[1]Net Th-232 activity concentration (pCi/g) is equal to the Gross Th-232 activity concentration minus the established background value of 1.1 pCi/g Th-232.

The net Th-232 activity concentrations for all 38 systematic composite samples were below the BCM surrogate value of 31.1 pCi/g net Th-232 activity concentration (DCCL). The maximum net Th-232 activity concentration was 23.0 pCi/g. The average net Th-232 activity concentration was 9.30 pCi/g. The standard deviation of the 38 composite samples was 4.64, which fell above the estimated standard deviation of 4.4 used to calculate the minimum number of samples required in the decommissioning plan.

Since the estimated variance (standard deviation) is greater than the variance used to calculate the minimum number of samples required (N), N was recalculated using the measured variance of 4.64 to ensure enough samples were taken, as follows:

Paramount to determining the minimum number of samples is the determination of the relative shift, delta over sigma (Δ/σ). Delta is equal to the DCGL minus the lower-bound gray region (LBGR) value. The LBGR value is arbitrarily set at one-half the DCGL value to start the determination. Sigma is an estimate of the variability in a set of sample analysis results from a survey unit. In the DP, the estimate of sigma used was based on the standard deviations in Th-232 activity measured in survey units during the FSS sampling of the adjacent land remediation final survey. The net Th-232 activity concentration of 31.1 pCi/g was used as the DCCL and Δ was equal to 31.1 – 15.55, or 15.55. Delta divided by the sigma of 4.4 resulted in a relative shift of 3.53 which is rounded to 3.5 for the purpose of determining the required number of samples. The number of samples was then looked up in Table 5.3 of MARSSIM (9 for selected alpha and beta error rates of 0.05).

Using the original net DCCL value of 31.1 pCi/g, a recalculation of N results in a delta of (31.1 – 15.55) of 15.55 and a relative shift of (15.55 / 4.64) of 3.4. The resulting N for a standard Class 1 survey unit of 2,000 m^2 is 9 (MARSSIM Table 5.3). Nine systematic core samples were taken resulting in 38 1-meter composite samples.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil core composite samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit core sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (23.75 pCi/g) between the maximum survey unit soil sample gross activity concentration (24.1 pCi/g) and the minimum reference background area soil sample activity concentration (0.35 pCi/g) is less than DCCL (31.1 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Gross Th-232 (pCi/g)
R1	308	0.38	S1	K-1573	5.62
R2	250	1.18	S2	K-1574	10.6
R3	46	0.58	S3	K-1575	19.2
R4	62	1.34	S4	K-1576	9.99
R5	1	0.98	S5	K-1577	10.4
R6	228	1.62	S6	K-1578	5.68
R7	307	1.02	S7	K-1579	8.04
R8	370	0.79	S8	K-1580	10.8
R9	323	0.87	S9	K-1581	14.3
R10	156	0.96	S10	K-1582	16.4
R11	322	1.38	S11	K-1583	11.0

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Gross Th-232 (pCi/g)
R12	3	0.35	S12	K-1584	10.0
R13	185	0.90	S13	K-1585	12.4
R14	75	1.27	S14	K-1586	6.72
R15	282	0.87	S15	K-1587	7.11
R16	371	0.84	S16	K-1588	11.9
R17	275	1.25	S17	K-1589	7.31
R18	125	0.81	S18	K-1590	9.07
R19	173	0.86	S19	K-1591	19.3
R20	177	0.64	S20	K-1592	6.84
R21	85	1.18	S21	K-1593	10.6
R22	365	0.74	S22	K-1594	13.0
R23	193	1.16	S23	K-1595	4.90
R24	42	0.90	S24	K-1596	6.41
R25	277	1.12	S25	K-1597	7.21
R26	367	1.02	S26	K-1598	14.3
R27	234	0.57	S27	K-1599	6.90
R28	56	1.17	S28	K-1600	16.2
R29	6	0.95	S29	K-1601	24.1
R30	240	1.08	S30	K-1602	11.7
R31	363	0.97	S31	K-1603	10.1
R32	277	1.12	S32	K-1604	12.1
R33	31	1.33	S33	K-1605	6.41
R34	102	1.04	S34	K-1606	5.02
R35	33	0.92	S35	K-1607	5.61
R36	250	1.18	S36	K-1608	9.84
R37	139	0.70	S37	K-1609	1.86
R38	171	1.16	S38	K-1610	15.5
	Average:	***0.98***		***Average:***	***10.4***
	Std. Dev.	***0.27***		***Std. Dev.***	***4.64***
	Minimum:	***0.35***		***Minimum:***	***1.86***
	Maximum:	***1.62***		***Maximum:***	***24.1***
	Median:	***0.98***		***Median:***	***10.1***

3.0 SUMMARY OF FINDINGS

Survey Unit Kaiser-FSSB-012, which consists of a unit of BCM placed in an excavation resulting from the removal of radiologically-affected soil from the Retention Pond area, is considered a Class 1 survey unit with an approximate base surface area of 1,840 m^2. It is located on the north side of the pond parcel within portions of excavation bottoms associated with Survey Units Kaiser-FSS-018, Kaiser-FSS-019, Kaiser-FSS-023, and Kaiser-FSS-028 (**Figure 3**). The survey unit is bordered by excavation backfill Survey Unit Kaiser-FSSB-010 to the north, excavation backfill Survey Unit Kaiser-FSSB-013 to the west, excavation backfill Survey Units Kaiser-FSSB-007 and Kaiser-FSSB-008 to the east, and a wall of non-impacted soil (clean import borrow material) to the south.

A total of seven 2-foot layers (lifts) of BCM was placed in Survey Unit Kaiser-FSSB-012.

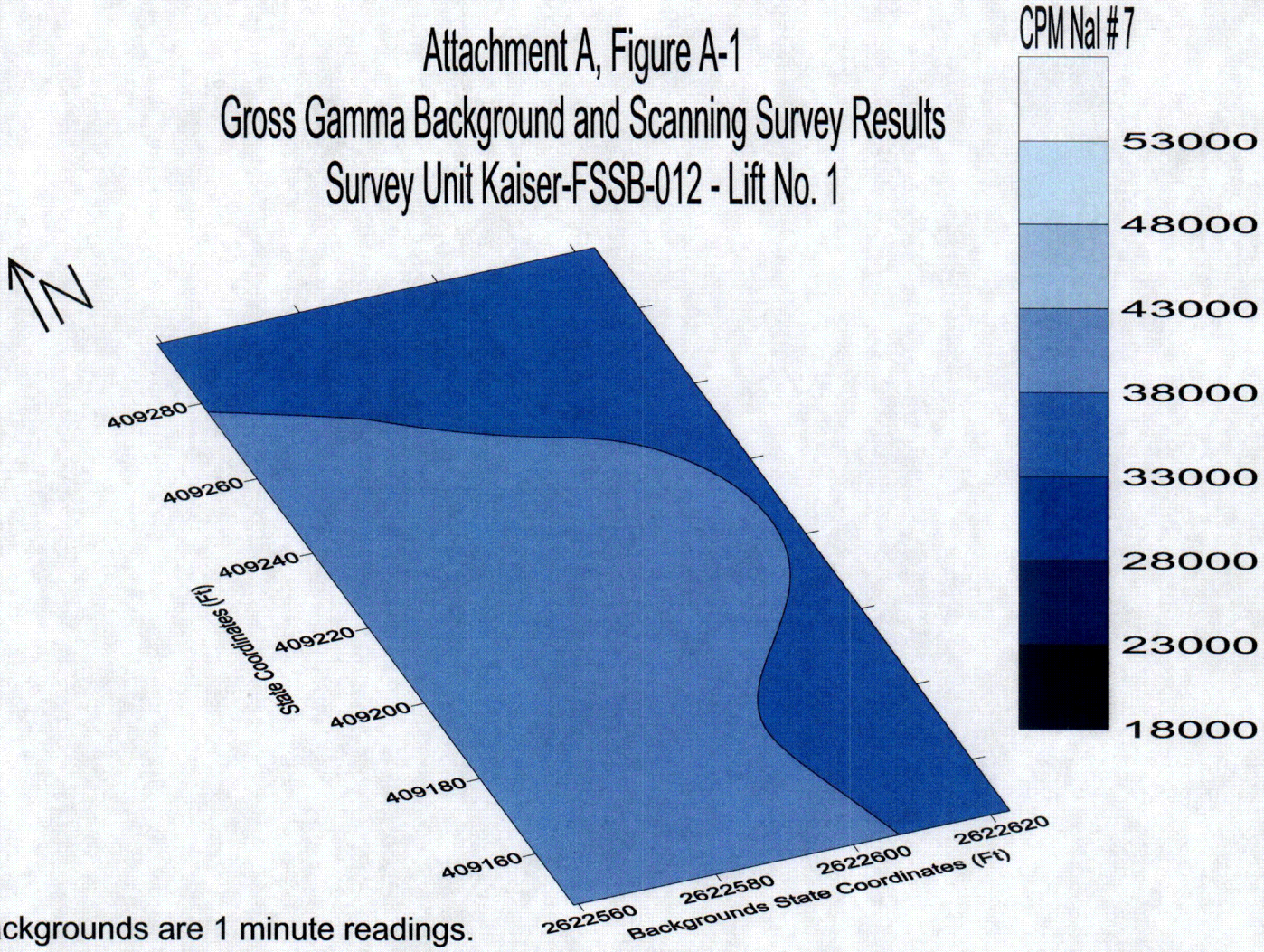
The acceptance criterion for BCM survey units at the Tulsa facility is the DCCL of 31.1 pCi/g net Th-232 activity concentration. The final status survey consisted of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan of each lift (final as-left condition) did not indicate the presence of small areas (1 m^2) of elevated activity (greater than the DCCL for the site).
- The net Th-232 activity concentrations for all 38 systematic composite core samples were below the BCM surrogate value of 31.1 pCi/g net Th-232 activity concentration (DCCL).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).

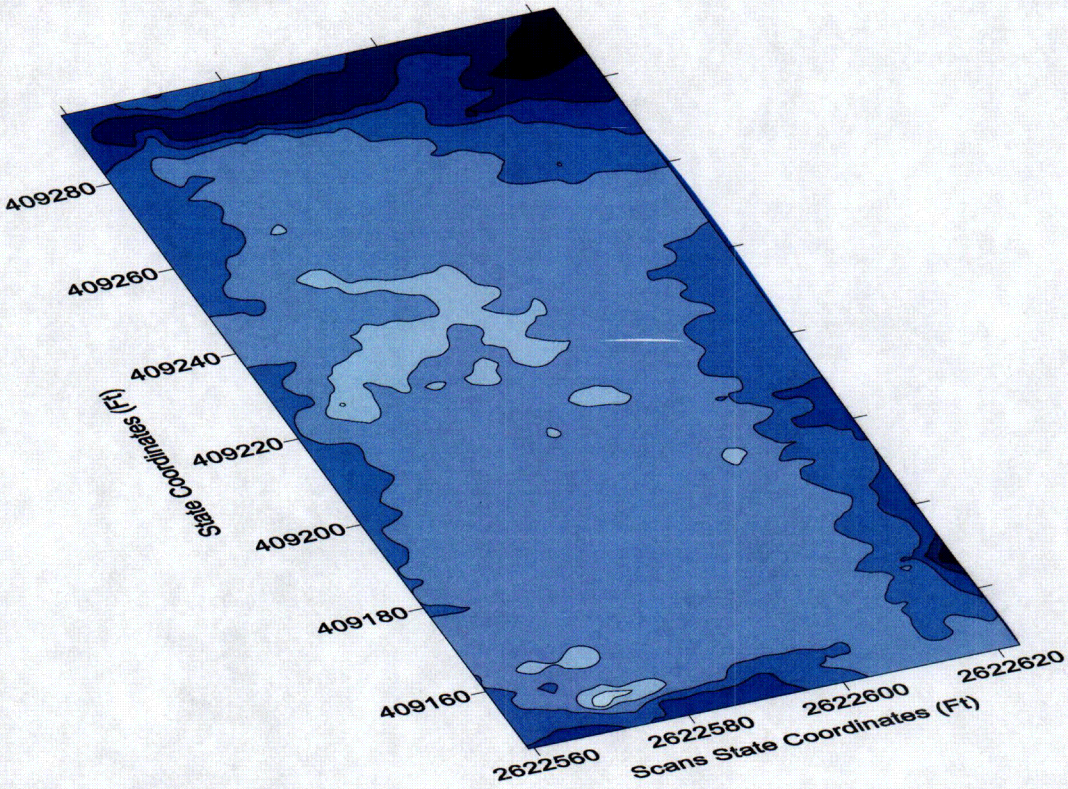
The results of the final status survey activities show that Survey Unit Kaiser-FSSB-012 meets the DP acceptance criteria.

ATTACHMENT A
TABLE OF CONTENTS

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-012 - Lift No. 1

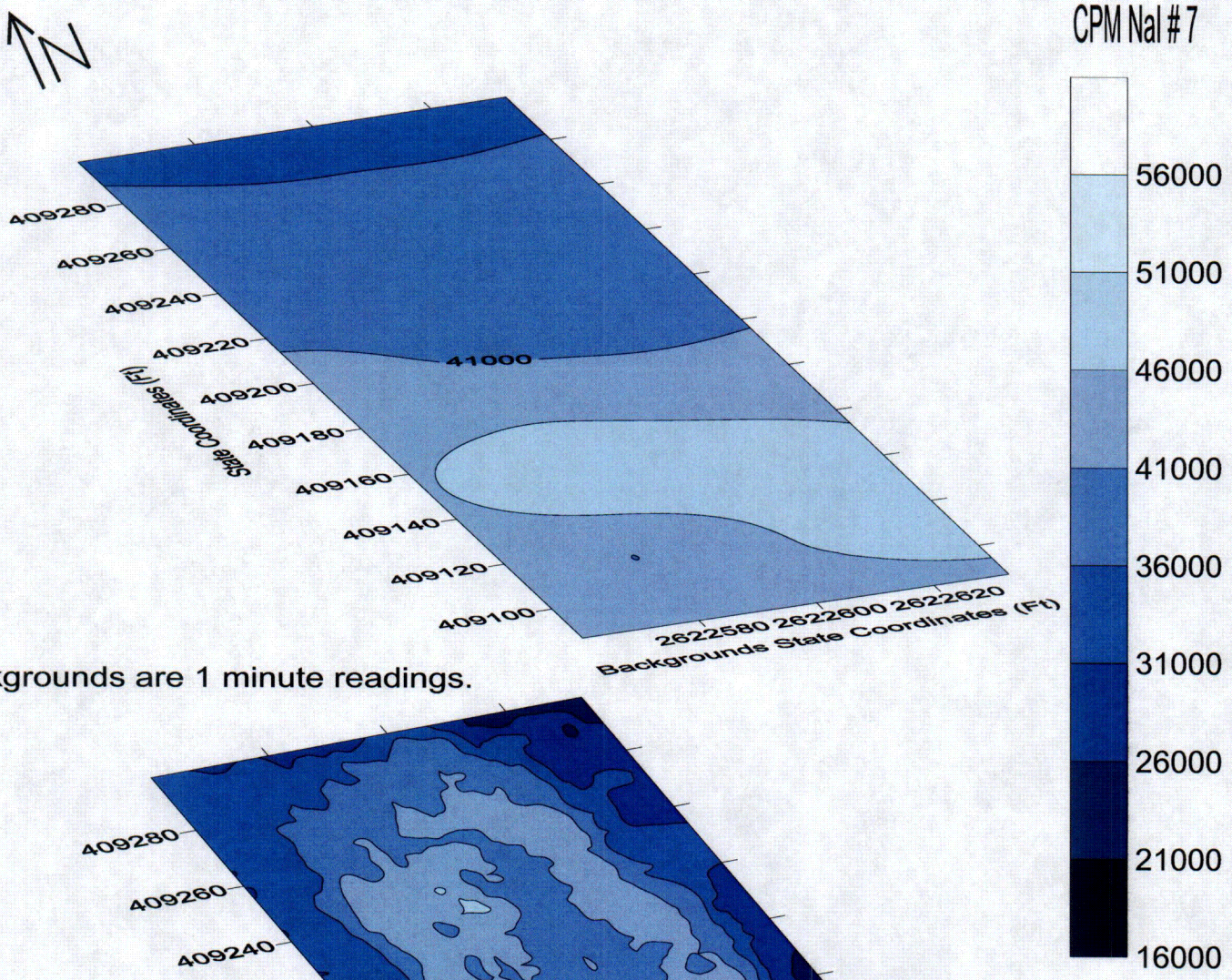


Backgrounds are 1 minute readings.

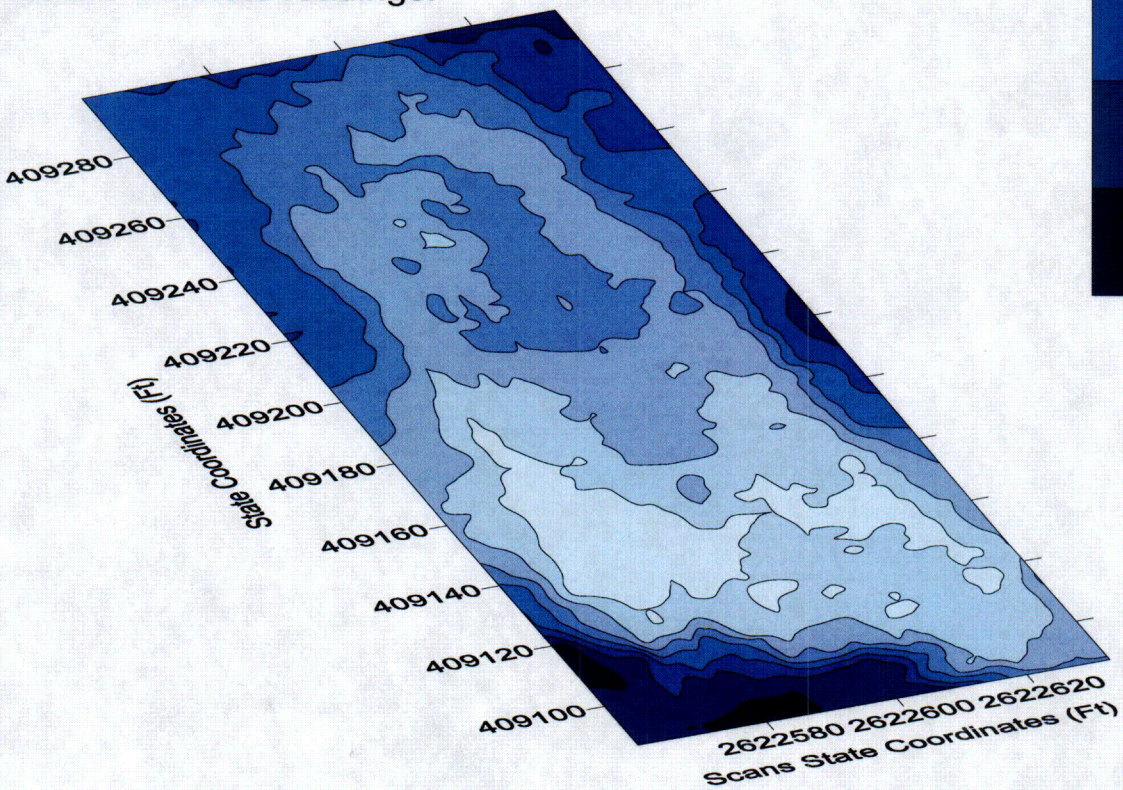


Scanning readings are recorded at 2 second intervals.

Attachment A, Figure A-2
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-012 - Lift No. 2

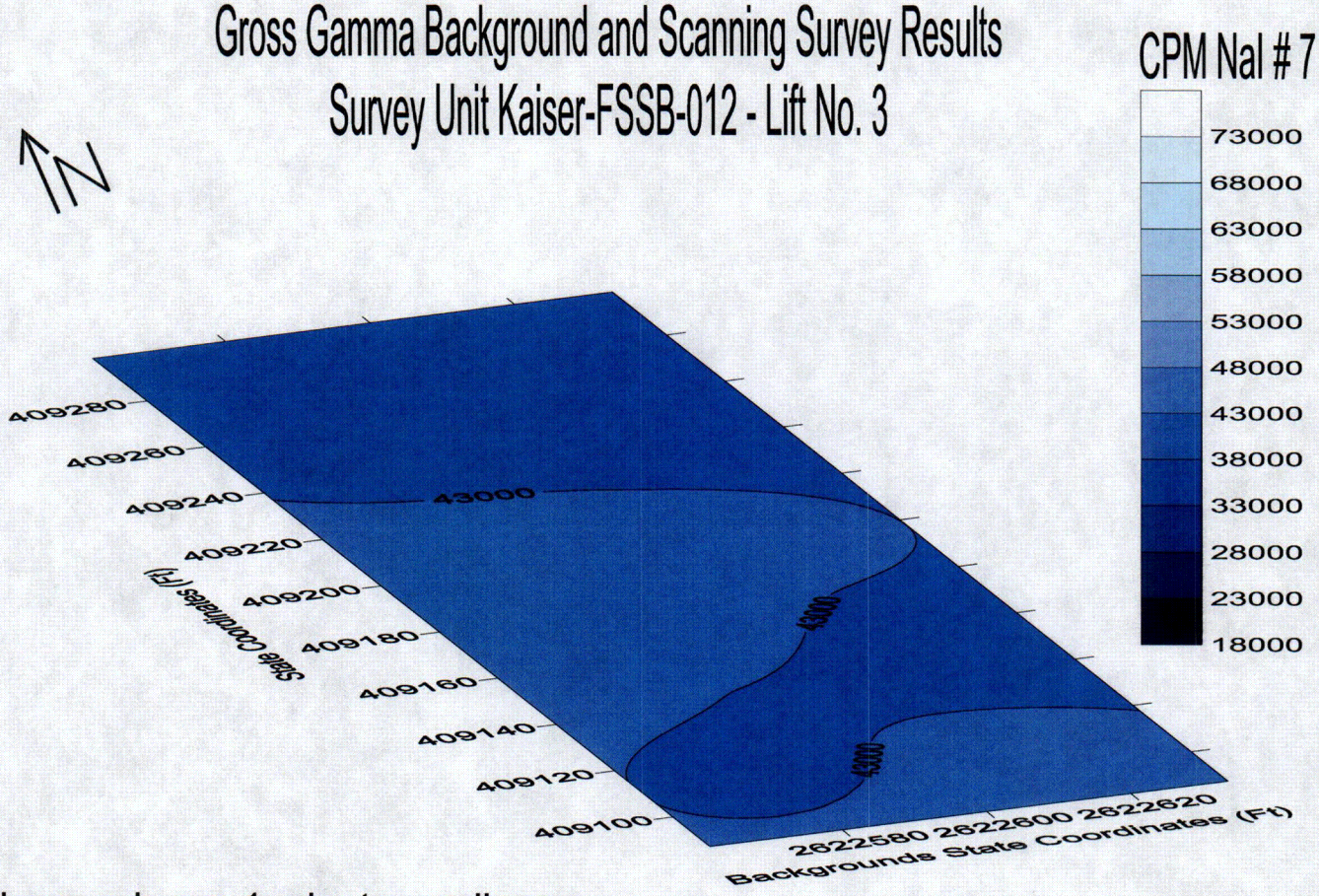


Backgrounds are 1 minute readings.

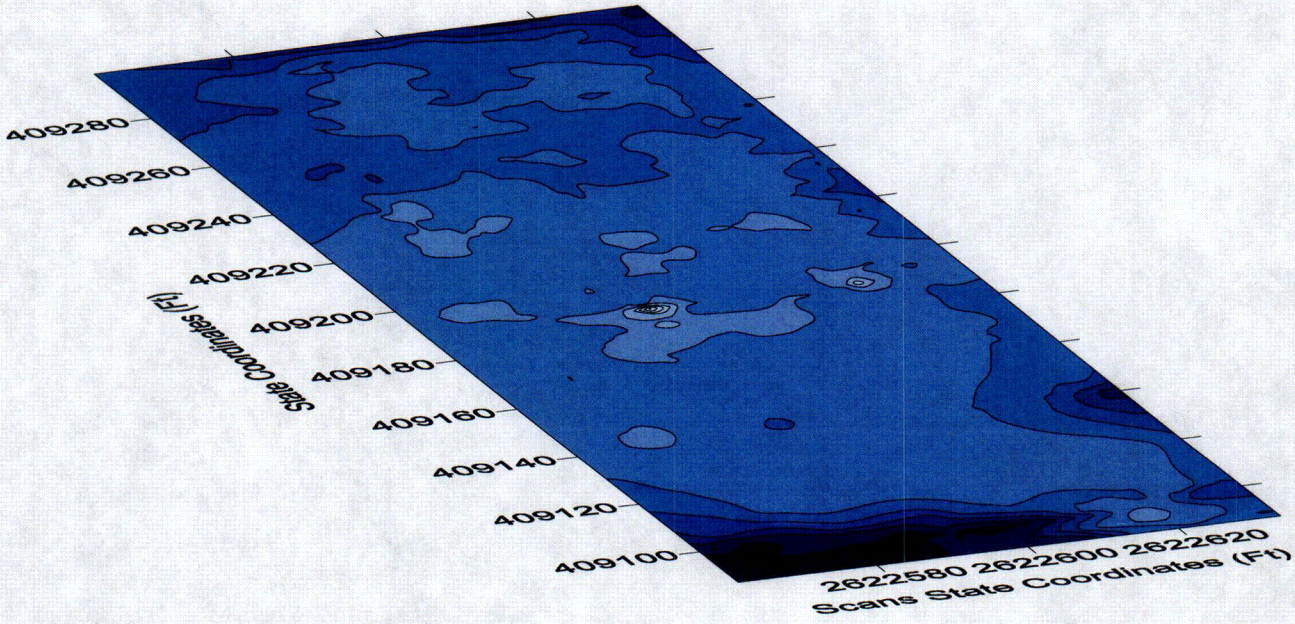


Scanning readings are recorded at 2 second intervals.

Attachment A, Figure A-3
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-012 - Lift No. 3

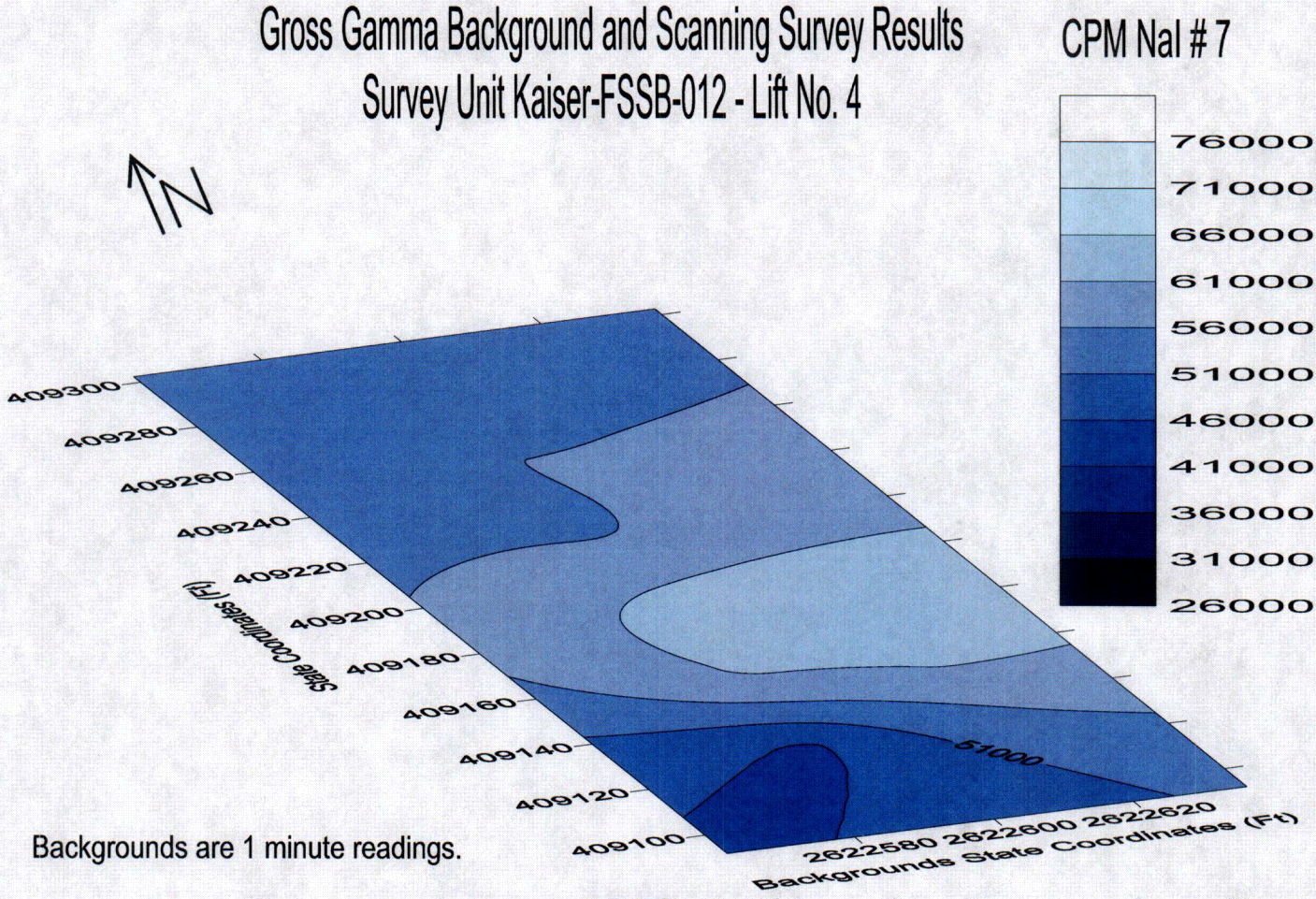


Backgrounds are 1 minute readings.

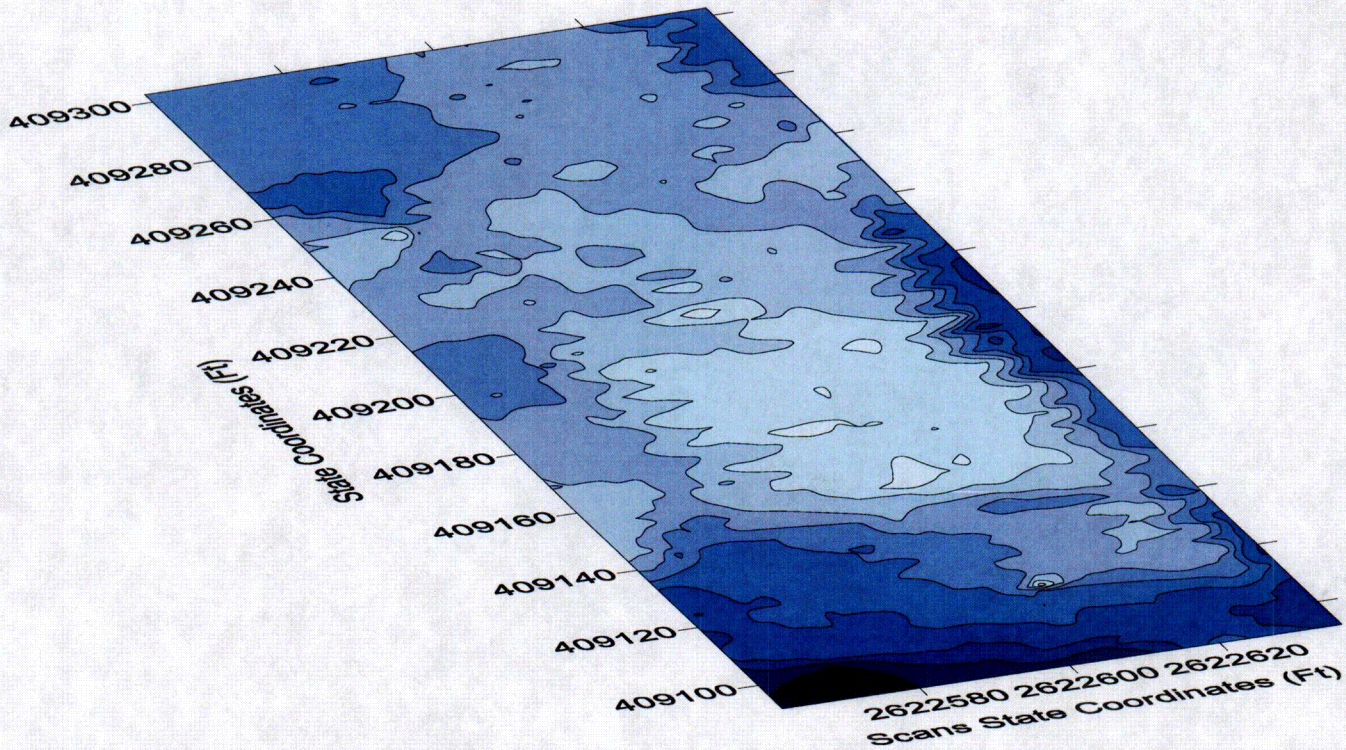


Scanning readings are recorded at 2 second intervals.

Attachment A, Figure A-4
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-012 - Lift No. 4

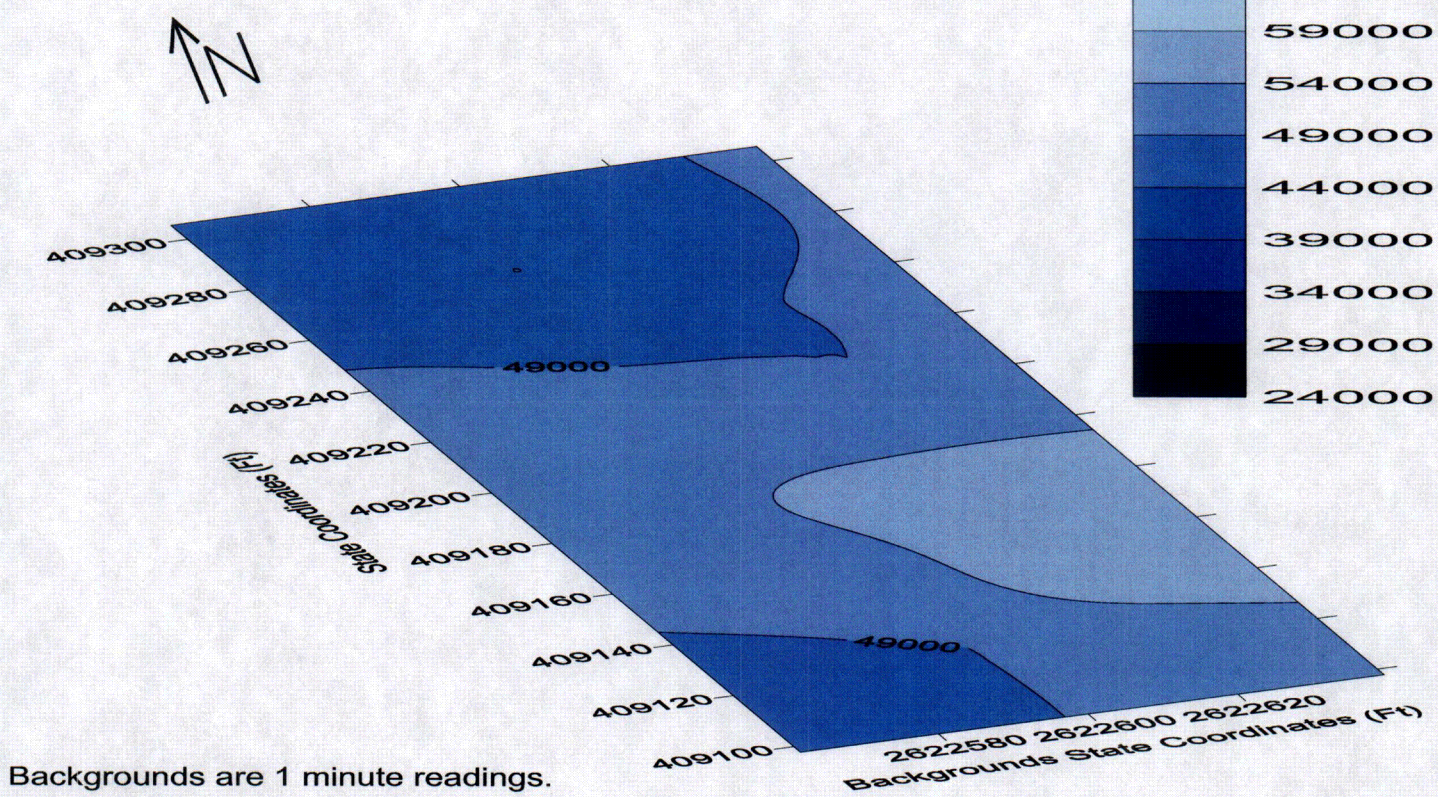


Backgrounds are 1 minute readings.



Scanning readings are recorded at 2 second intervals.

Attachment A, Figure A-5
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-012 - Lift No. 5



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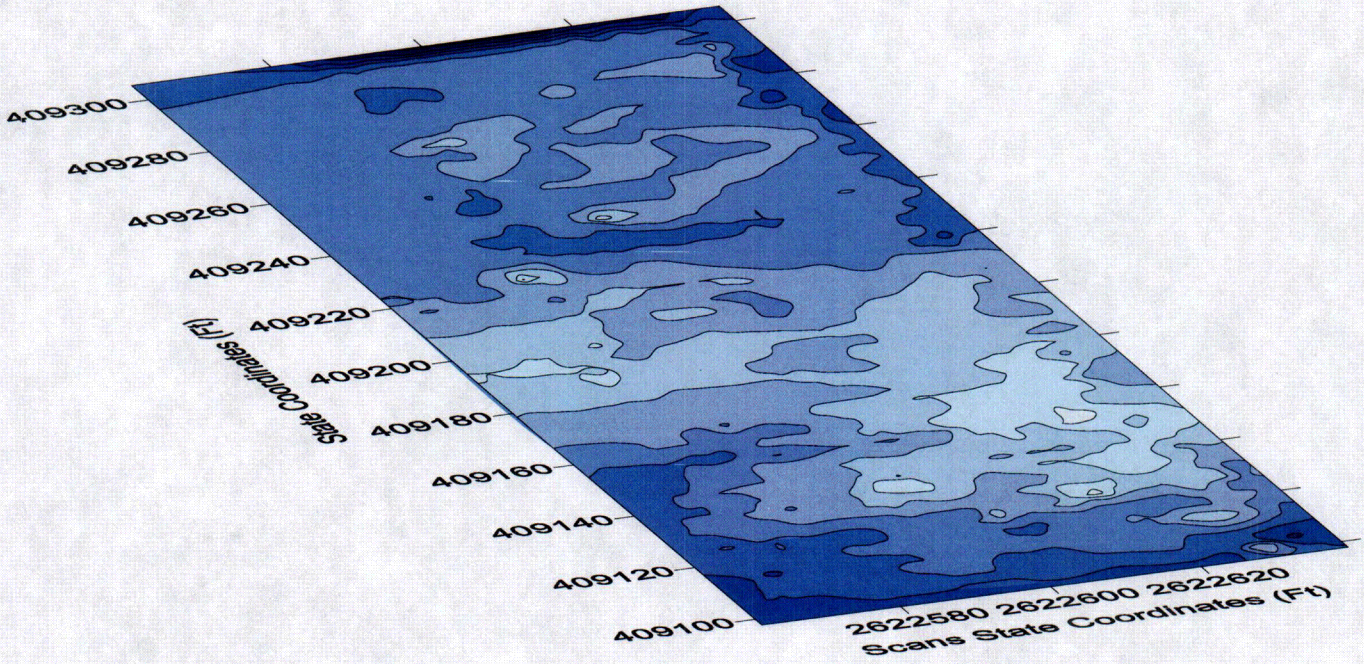
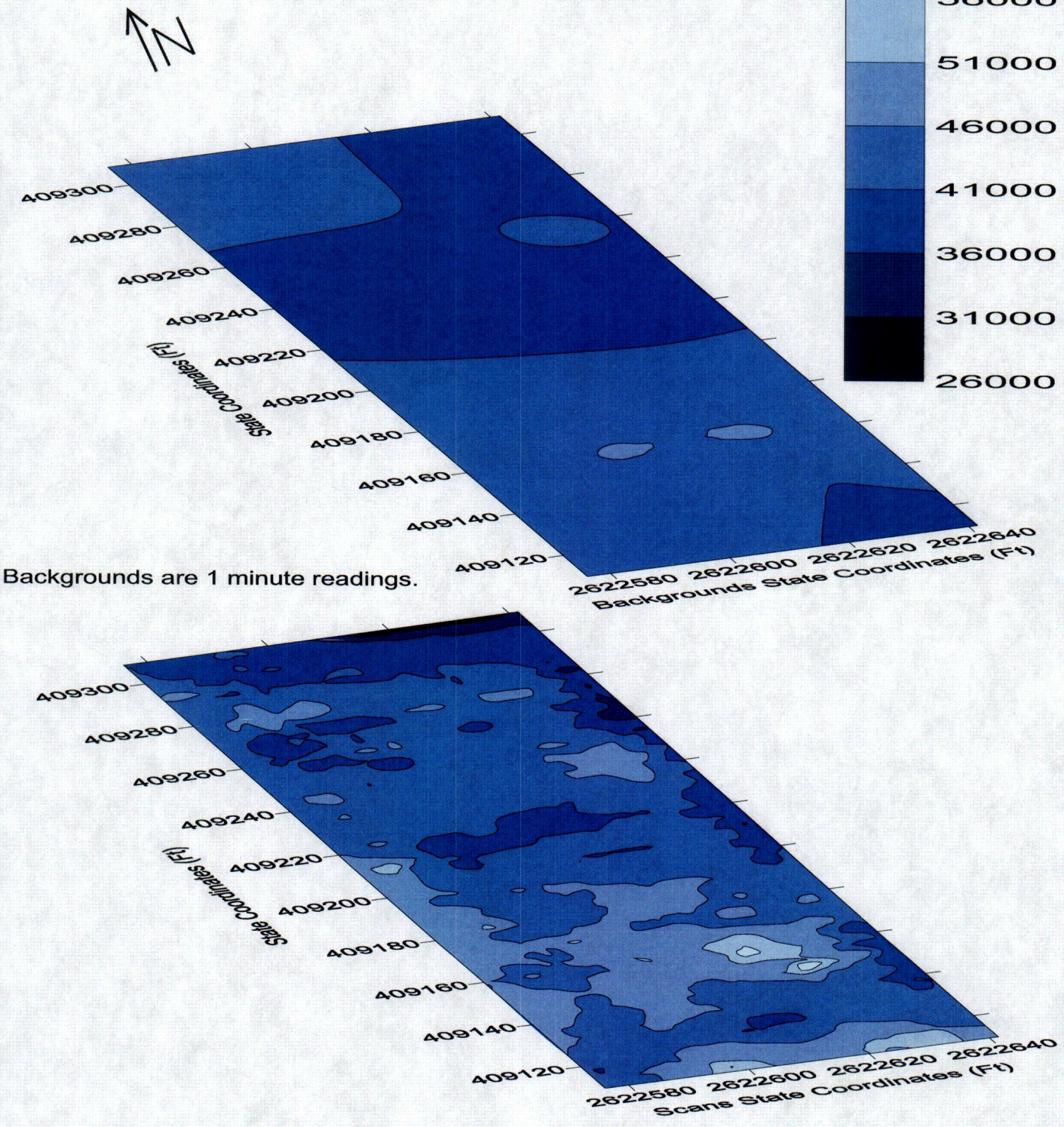


Scanning readings are recorded at 2 second intervals.

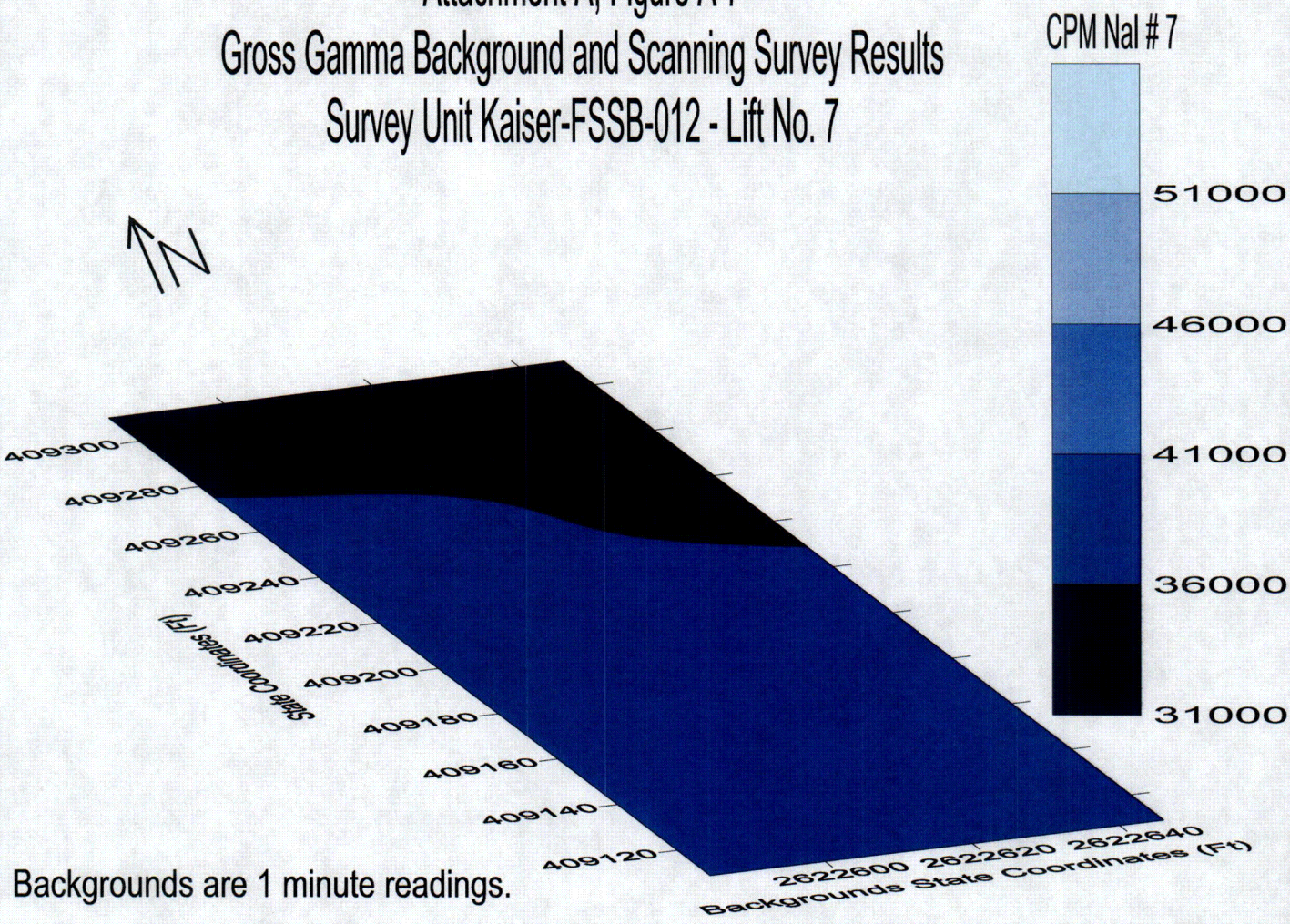
Attachment A, Figure A-6
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-012 - Lift No. 6



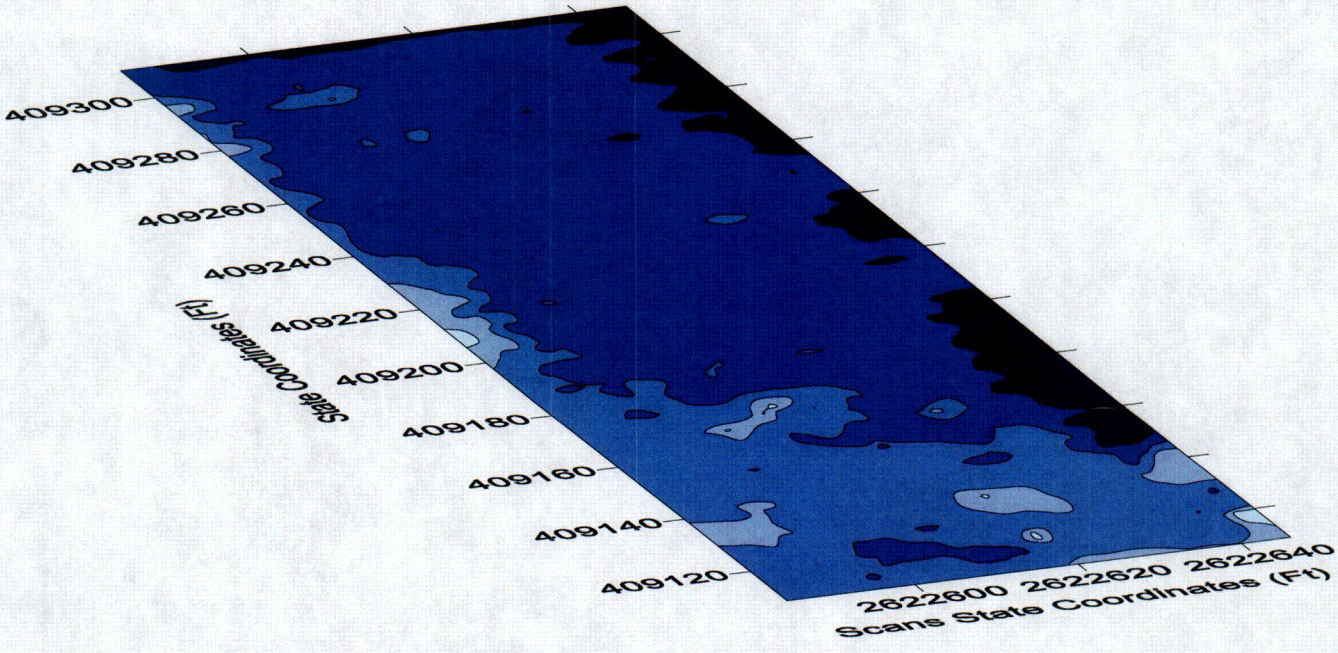
Backgrounds are 1 minute readings.

Scanning readings are recorded at 2 second intervals.

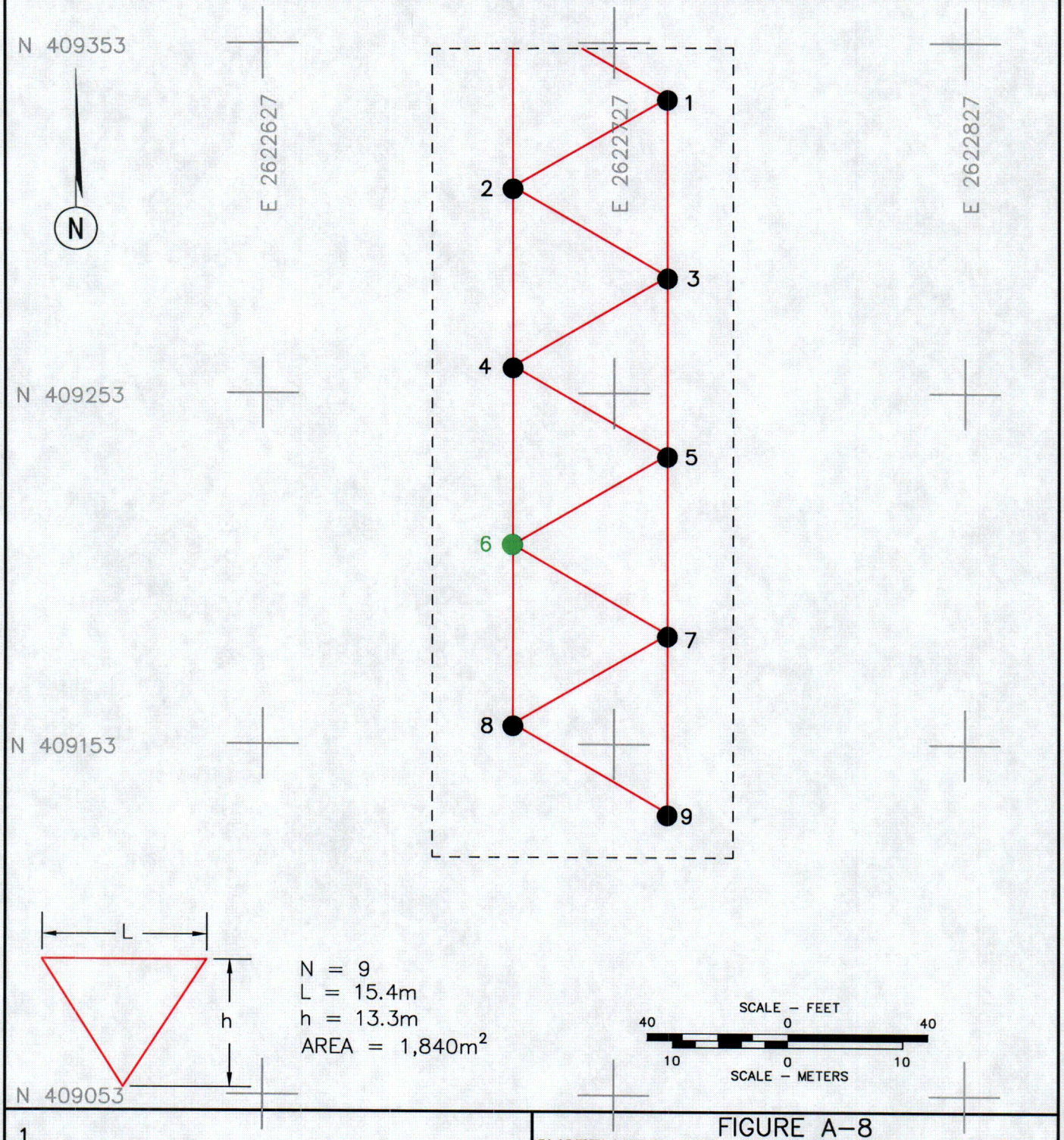
Attachment A, Figure A-7
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSSB-012 - Lift No. 7



Backgrounds are 1 minute readings.



Scanning readings are recorded at 2 second intervals.



1 ● SYSTEMATIC SOIL CORE SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

6 ● RANDOM START POINT

FIGURE A–8
SYSTEMATIC SOIL CORE SAMPLING LOCATIONS SURVEY UNIT KAISER – FSSB–012 FINAL STATUS SURVEY THORIUM REMEDIATION PROJECT TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	
CHECKED	
DRAWN	DEB 05/26/06
DRAWING NUMBER	PA4072080A

Penn E&R
Environmental & Remediation, Inc.

H:\4000-PA\2\PA4072080A.dwg, 7/11/2006 9:11:25 AM

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: Kaiser-FSSB-012

2. Description: Pond Parcel Excavation Backfill Unit

3. Net Th-232 Acceptance Criteria (pCi/g): 31.1

4. Dimensions (m): Approximately 26 meters x 70 meters; Area, A (m^2): 1,840

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 75,000 Minimum: 50,000 Maximum: 100,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 5.7
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 15.4

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 13.3 m.

1

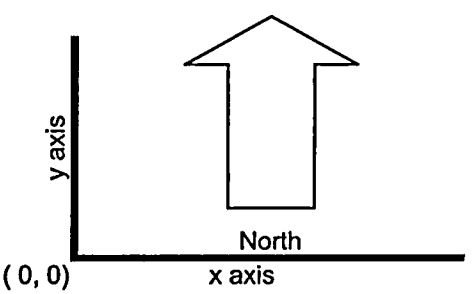
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSSB-012

RANDOM START POINT

x axis (Meters)	y axis (Meters)
7	27

	x axis	y axis
lower bound	0	0
upper bound	26	70



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
511 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Invoice # 11996

Dt. 4/28/06

April 28, 2006

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20060256

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on March 31, 2006 for the above captioned project. Forty-one soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with a standard 20-work day turn. Results were faxed on 4/28/06.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20060256
Date Reported: 4/28/06
Date Received: 3/31/06

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20060256-01						
Client ID:	K-1573						
Date Sampled:	3/30/06 8:05:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.62 +/- 0.448	pCi/g	0.427		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.0	%		4/1/06	4/3/06	RT
Lab ID:	20060256-02						
Client ID:	K-1574						
Date Sampled:	3/30/06 8:15:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	10.6 +/- 0.526	pCi/g	0.286		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.9	%		4/1/06	4/3/06	RT
Lab ID:	20060256-03						
Client ID:	K-1575						
Date Sampled:	3/30/06 8:25:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	19.2 +/- 0.900	pCi/g	0.448		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	22.4	%		4/1/06	4/3/06	RT
Lab ID:	20060256-04						
Client ID:	K-1576						
Date Sampled:	3/30/06 8:30:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	9.99 +/- 0.509	pCi/g	0.363		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.7	%		4/1/06	4/3/06	RT
Lab ID:	20060256-05						
Client ID:	K-1577						
Date Sampled:	3/30/06 8:35:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20060256
Date Reported: 4/28/06
Date Received: 3/31/06

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	10.4 +/- 0.636	pCi/g	0.427		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.1	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-06**						
Client ID:	**K-1578**						
Date Sampled:	**3/30/06 8:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.68 +/- 0.436	pCi/g	0.294		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.7	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-07**						
Client ID:	**K-1579**						
Date Sampled:	**3/30/06 8:45:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	8.04 +/- 0.281	pCi/g	0.304		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.4	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-08**						
Client ID:	**K-1580**						
Date Sampled:	**3/30/06 8:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	10.8 +/- 0.569	pCi/g	0.397		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.3	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-09**						
Client ID:	**K-1581**						
Date Sampled:	**3/30/06 8:52:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	14.3 +/- 0.709	pCi/g	0.367		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	23.2	%		4/1/06	4/3/06	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060256
Date Reported:	4/28/06
Date Received:	3/31/06
Page Number:	3 of 10

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20060256-10**						
Client ID:	**K-1582**						
Date Sampled:	**3/30/06 8:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	16.4 +/- 0.740	pCi/g	0.343		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	19.0	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-11**						
Client ID:	**K-1583**						
Date Sampled:	**3/30/06 8:57:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	11.0 +/- 0.581	pCi/g	0.342		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.9	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-12**						
Client ID:	**K-1584**						
Date Sampled:	**3/30/06 9:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	10.0 +/- 0.660	pCi/g	1.08		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	18.1	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-13**						
Client ID:	**K-1585**						
Date Sampled:	**3/30/06 9:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	12.4 +/- 1.02	pCi/g	0.860		4/3/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.6	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-14**						
Client ID:	**K-1586**						
Date Sampled:	**3/30/06 9:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach
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Broken Arrow, OK 74012
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Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	6.72 +/- 0.508	pCi/g	0.503		4/4/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.3	%		4/1/06	4/3/06	RT
Lab ID:	20060256-15						
Client ID:	K-1587						
Date Sampled:	3/30/06 9:12:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	7.11 +/- 0.445	pCi/g	0.274		4/4/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.1	%		4/1/06	4/3/06	RT
Lab ID:	20060256-16						
Client ID:	K-1588						
Date Sampled:	3/30/06 9:20:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	11.9 +/- 0.817	pCi/g	0.961		4/4/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	19.0	%		4/1/06	4/3/06	RT
Lab ID:	20060256-17						
Client ID:	K-1589						
Date Sampled:	3/30/06 9:25:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	7.31 +/- 0.369	pCi/g	0.261		4/4/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.1	%		4/1/06	4/3/06	RT
Lab ID:	20060256-18						
Client ID:	K-1590						
Date Sampled:	3/30/06 9:30:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	9.07 +/- 0.585	pCi/g	0.499		4/4/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.6	%		4/1/06	4/3/06	RT

BDL = Below Detection Limit

Outreach
oratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20060256
Date Reported: 4/28/06
Date Received: 3/31/06

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20060256-19						
Client ID:	K-1591						
Date Sampled:	3/30/06 9:35:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	19.3 +/- 0.966	pCi/g	0.464		4/5/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	21.8	%		4/1/06	4/3/06	RT
Lab ID:	20060256-20						
Client ID:	K-1592						
Date Sampled:	3/30/06 9:40:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	6.84 +/- 0.550	pCi/g	0.719		4/5/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.8	%		4/1/06	4/3/06	RT
Lab ID:	20060256-21						
Client ID:	K-1593						
Date Sampled:	3/30/06 9:45:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	10.6 +/- 0.611	pCi/g	0.290		4/5/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.2	%		4/1/06	4/3/06	RT
Lab ID:	20060256-22						
Client ID:	K-1594						
Date Sampled:	3/30/06 9:50:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	13.0 +/- 0.760	pCi/g	0.586		4/5/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.6	%		4/1/06	4/3/06	RT
ab ID:	20060256-23						
lient ID:	K-1595						
Date Sampled:	3/30/06 9:55:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20060256
Date Reported: 4/28/06
Date Received: 3/31/06

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	4.90 +/- 0.427	pCi/g	0.291		4/5/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.7	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-24**						
Client ID:	**K-1596**						
Date Sampled:	**3/30/06 10:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	6.41 +/- 0.342	pCi/g	0.474		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.0	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-25**						
Client ID:	**K-1597**						
Date Sampled:	**3/30/06 10:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	7.21 +/- 0.400	pCi/g	0.284		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	18.1	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-26**						
Client ID:	**K-1598**						
Date Sampled:	**3/30/06 10:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	14.3 +/- 0.810	pCi/g	0.445		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.6	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-27**						
Client ID:	**K-1599**						
Date Sampled:	**3/30/06 10:15:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	6.90 +/- 0.424	pCi/g	0.294		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	18.4	%		4/1/06	4/3/06	RT

BDL = Below Detection Limit

Outreach
oratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20060256-28						
Client ID:	K-1600						
Date Sampled:	3/30/06 10:20:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	16.2 +/- 0.839	pCi/g	0.425		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	24.9	%		4/1/06	4/3/06	RT
Lab ID:	20060256-29						
Client ID:	K-1601						
Date Sampled:	3/30/06 10:25:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	24.1 +/- 1.06	pCi/g	0.608		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	26.0	%		4/1/06	4/3/06	RT
Lab ID:	20060256-30						
Client ID:	K-1602						
Date Sampled:	3/30/06 10:30:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	11.7 +/- 0.564	pCi/g	0.315		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.4	%		4/1/06	4/3/06	RT
Lab ID:	20060256-31						
Client ID:	K-1603						
Date Sampled:	3/30/06 10:35:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	10.1 +/- 0.422	pCi/g	0.279		4/7/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.2	%		4/1/06	4/3/06	RT
Lab ID:	20060256-32						
Client ID:	K-1604						
Date Sampled:	3/30/06 10:40:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060256
Date Reported:	4/28/06
Date Received:	3/31/06
Page Number:	8 of 10

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	12.1 +/- 0.479	pCi/g	0.358		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.5	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-33**						
Client ID:	**K-1605**						
Date Sampled:	**3/30/06 10:45:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	6.41 +/- 0.286	pCi/g	0.317		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.9	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-34**						
Client ID:	**K-1606**						
ate Sampled:	**3/30/06 10:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.02 +/- 0.447	pCi/g	0.497		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.4	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-35**						
Client ID:	**K-1607**						
Date Sampled:	**3/30/06 10:52:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	5.61 +/- 0.549	pCi/g	1.06		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.2	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-36**						
Client ID:	**K-1608**						
Date Sampled:	**3/30/06 10:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	9.84 +/- 0.621	pCi/g	0.391		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.5	%		4/1/06	4/3/06	RT

BDL = Below Detection Limit

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060256
Date Reported:	4/28/06
Date Received:	3/31/06
Page Number:	9 of 10

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20060256-37**						
Client ID:	**K-1609**						
Date Sampled:	**3/30/06 11:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.86 +/- 0.240	pCi/g	0.236		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.0	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-38**						
Client ID:	**K-1610**						
Date Sampled:	**3/30/06 11:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	15.5 +/- 1.02	pCi/g	1.51		4/6/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	21.8	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-39**						
Client ID:	**K-1633**						
Date Sampled:	**3/30/06 2:25:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	45.1 +/- 1.54	pCi/g	0.484		4/7/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	23.0	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-40**						
Client ID:	**K-1636**						
Date Sampled:	**3/30/06 1:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.612 +/- 0.185	pCi/g	0.527		4/7/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.4	%		4/1/06	4/3/06	RT
Lab ID:	**20060256-41**						
Client ID:	**K-1637**						
Date Sampled:	**3/30/06 2:15:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
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Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060256
Date Reported:	4/28/06
Date Received:	3/31/06
Page Number:	10 of 10

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	79.7 +/- 2.44	pCi/g	0.728		4/7/06	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	49.1	%		4/1/06	4/3/06	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					5.9				4/7/06
Ac-228					8.1				4/5/06
Ac-228					0.3				4/3/06
Am-241		85.0	90.0	5.7					4/7/06
Am-241		84.0	91.0	7.5					4/5/06
Am-241		94.0	94.0	0.9					4/3/06
Co-60		95.0	94.0	0.6					4/7/06
Co-60		95.0	95.0	0.2					4/5/06
Co-60		95.0	96.0	0.3					4/3/06
Cs-137		88.0	95.0	7.2					4/7/06
Cs-137		88.0	94.0	6.5					4/5/06
Cs-137		96.0	95.0	0.7					4/3/06
Percent Moisture					0.4				4/3/06
Percent Moisture					8.7				4/3/06
Percent Moisture					6.3				4/3/06

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: LOCAL: 918-384-0586 Cell: 724-799-0071
Company: Kaiser - Alum & Chem Inc.
Name: David B. Weyant
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3530 Fax #: 918-384-3171

Bill To:
Company: Kaiser/Penn E&R
Name: Paul Harper / David Weyant
Address: 7311 E. 41st
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser-thorium Remed.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 20 DAY
SAMPLER Signature: David Weyant × Dale Duffey 2006

CONTAINER SIZE: PLASTIC OR GLASS
PRESERVATIVE #: 1. HNO_3 pH<2 2. Ice <4°C 3. HCl pH<2 4. H_2SO_4 pH<2 5. NaOH pH>11

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE (Plastic)	PRESERVATIVE	Gamma Spec (Th-232)	Return to Client for Archive	MDC < 0.5 pCi/g	ASTM 2216-92 Moist Content					REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1573	3-30	0805 ~~7:55~~	Soil	1	500ml	None	X	X	X	X					GRAB
	K-1574		8:15		1			X	X	X	X					
	K-1575		0825 ~~8:20~~		1			X	X	X	X					
	K-1576		0833 ~~8:30~~		1			X	X	X	X					
	K-1577		8:35		1			X	X	X	X					
	K-1578		8:40		1			X	X	X	X					
	K-1579		8:45		1			X	X	X	X					
	K-1580		8:50		1			X	X	X	X					
	K-1581		8:52		1			X	X	X	X					
	K-1582		8:55		1			X	X	X	X					
	K-1583		8:57		1			X	X	X	X					
	K-1584		9:00		1			X	X	X	X					
	K-1585		9:05		1			X	X	X	X					
	K-1586		9:10		1			X	X	X	X					

RELINQUISHED BY: David B. Weyant DATE: 3/31/06 TIME: 930 RECEIVED BY: Donna Eidson DATE: 3/31/06 TIME: 930

RELINQUISHED BY: ________ DATE: ____ TIME: ____ RECEIVED BY: ________ DATE: ____ TIME: ____

FOR LABORATORY USE ONLY: [illegible]
Sample Condition Upon Receipt: Good
Custody Seal Intact: [illegible]
Cooler Temperature: [illegible]

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Local: 918-384-0566 Cell: 774-799-0071
Company: Kaiser-Alum & Chem Inc.
Name: David B. Weyant
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145
Phone: 774-934-3xx0 Fax #: 918-384-3171

Bill To:
Company: Kaiser/PAW E&R
Name: David B. Weyant / Paul Hadda
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser-Thorium Remed.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 30 Days
SAMPLER Signature: Dave Weyant 2006 / Dave Bobby

Container size: 500 ml — Plastic or Glass

PRESERVATIVE #: 1. HNO_3 pH<2 2. Ice <4°C 3. HCl pH<2 4. H_2SO_4 pH<2 5. NaOH pH>11

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE	PRESERVATIVE #	Gamma Spec (Th-232)	Return to client for Archive	Moe Coy Pull in	Amr Th-232 Moisture Correct				REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
[illegible]	K-1587	3-30	9:12	Soil	1	Plastic	None	X	X	X	X		N/A		Grab
[illegible]	K-1588		9:20		1			X	X	X	X				
[illegible]	K-1589		9:25		1			X	X	X	X				
[illegible]	K-1590		9:30		1			X	X	X	X				
[illegible]	K-1591		9:35		1			X	X	X	X				
[illegible]	K-1592		9:40		1			X	X	X	X				
[illegible]	K-1593		9:45		1			X	X	X	X				
[illegible]	K-1594		9:50		1			X	X	X	X				
[illegible]	K-1595		9:55		1			X	X	X	X				
[illegible]	K-1596		10:00		1			X	X	X	X				
[illegible]	K-1597		10:05		1			X	X	X	X				
[illegible]	K-1598		10:10		1			X	X	X	X				
[illegible]	K-1599		10:15		1			X	X	X	X				
[illegible]	K-1600		10:20		1			X	X	X	X				

RELINQUISHED BY: David R. Weyant DATE 3/31/06 TIME 930 RECEIVED BY: Donna Eidson DATE 3/31/06 TIME 930

RELINQUISHED BY: ________ DATE ______ TIME ______ RECEIVED BY: ________ DATE ______ TIME ______

FOR LABORATORY USE ONLY: 2006-0950-02
Sample Condition Upon Receipt: Good
Custody Seal Intact: Y N
Cooler Temperature: N/A

OUTREACH LABORATORY
311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: LOCAL: 918-384-0766 CELL: 774-799-0071
Company: Kaiser Alum & Chem Inc.
Name: David G. Weyant
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3530 Fax #: 918-384-3171

Bill To:
Company: Kaiser / Penn E&R
Name: David G. Weyant Pam Hadden
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser-Thorium Remed.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 20 DAYS
SAMPLER Signature: Dave Weyant / 2006 Dave Wells

Container size: Plastic or Glass
Preservative #: 1. HNO_3 pH<2 2. Ice <4°C 3. HCl pH<2 4. H_2SO_4 pH<2 5. NaOH pH>11

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE (Plastic)	PRESERVATIVE	Gamma Spec (Th-232)	Return to client for archive	MOC, Lois, P4/CP	ASTM 2216-92 Moist. Content					REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
29	K-1601	3-30	10:25	Soil	1	500ml	None	X	X	X	X					GRAB
30	K-1602		10:30		1			X	X	X	X					
31	K-1603		10:35		1			X	X	X	X					
32	K-1604		10:40		1			X	X	X	X					
33	K-1605		10:45		1			X	X	X	X					
34	K-1606		10:50		1			X	X	X	X					
35	K-1607		10:52		1			X	X	X	X					
36	K-1608		10:55		1			X	X	X	X					
37	K-1609		11:00		1			X	X	X	X					
38	K-1610		11:05		1			X	X	X	X					
39	K-1633	3-30	14:25		1			X	X	X	X					
40	K-1636		13:00		1			X	X	X	X					
41	K-1637		14:15		1			X	X	X	X					
	N/A	N/A	N/A	N/A	N/A		N/A	N/A				N/A		N/A		N/A

RELINQUISHED BY: David G. Weyant DATE: 3/31/06 TIME: 930 RECEIVED BY: Donna Eidson DATE: 3/31/06 TIME: 930

RELINQUISHED BY: ________ DATE: ____ TIME: ____ RECEIVED BY: ________ DATE: ____ TIME: ____

FOR LABORATORY USE ONLY: [illegible]-03
Sample Condition on Receipt: [illegible]
Custody Seal Intact: Y N
Cooler Temperature: [illegible]

SAMPLE I IN

Date Received: *3/31/06 10:19:38* **Lab Number:** 20060256 **Due:** 4/28/06

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20060256-01 A	K-1573	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-02 A	K-1574	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-03 A	K-1575	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-04 A	K-1576	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060256-05 A	K-1577	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060256-06 A	K-1578	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060256-07 A	K-1579	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060256-08 A	K-1580	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-09 A	K-1581	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060256-10 A	K-1582	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes

Th-232 [illegible] nma Spec								
20060256-11 A K-1583 Gamma Spec - Thorium 232 Percent Moisture (LOD)		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
20060256-12 A K-1584 Gamma Spec - Thorium 232 Percent Moisture (LOD)		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
20060256-13 A K-1585 Gamma Spec - Thorium 232 Percent Moisture (LOD)		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
20060256-14 A K-1586 Gamma Spec - Thorium 232 Percent Moisture (LOD)		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
20060256-15 A K-1587 Percent Moisture (LOD) Th-232 by Gamma Spec		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
20060256-16 A K-1588 Percent Moisture (LOD) Th-232 by Gamma Spec		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
20060256-17 A K-1589 Percent Moisture (LOD) Th-232 by Gamma Spec		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
20060256-18 A K-1590 Gamma Spec - Thorium 232 Percent Moisture (LOD)		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
20060256-19 A K-1591 Gamma Spec - Thorium 232 Percent Moisture (LOD)		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
20060256-20 A K-1592 Gamma Spec - Thorium 232 Percent Moisture (LOD)		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes

[illegible]	[illegible]		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent [illegible]ure (LOD)								
Th-232 by Gamma Spec								
20060256-22 A	K-1594		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-23 A	K-1595		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060256-24 A	K-1596		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-25 A	K-1597		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-26 A	K-1598		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-27 A	K-1599		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-28 A	K-1600		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060256-29 A	K-1601		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-30 A	K-1602		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-31 A	K-1603		Soil	03/30/06	Plastic	16 oz	None	Yes	Yes

Percent I ire (LOD)								
20060256-32 A	K-1604	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060256-33 A	K-1605	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-34 A	K-1606	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-35 A	K-1607	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060256-36 A	K-1608	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-37 A	K-1609	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-38 A	K-1610	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-39 A	K-1633	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-40 A	K-1636	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20060256-41 A	K-1637	Soil	03/30/06	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								

CONTAIN NSPECTION

Coolers 1 Custody Seals Broken ☐ Temperature: C Ice Radiation Survey: <300 cpm

SAMPLE INSPECTION

Sample Seal Broken Chain of Custody Record ☑ Labels in Tact ☑ Radiation Survey Complete ☐

Anomalies

Inspected By: Jessica Foster DATE 03/31/06

QA or Designee Review: Raymond Thomas DATE 03/31/06

Sample Custodian Review: K.D. Gregory DATE 3/31/06

Project Notes: